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TECHNICAL PUBLICATION 74-1

February, 1974

CHEMICAL QUALITY OF WATER IN CONSERVATION AREA 2A AND ASSOCIATED CANALS

Technical Publication #74-1

CHEMICAL QUALITY OF WATER IN CONSERVATION AREA 2A AND ASSOCIATED CANALS

by

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February, 1974

Revised

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West Palm Beach, Florida

Revisions

The following pages have been revised from the original February, 1974 publication:

Page v (Content revised previously.)
Page viii (Content revised previously; page number added 12/1/89.)
Page ix (Page number added 12/1/89.)
Pages 30, 31, 34, 35, 36 (Page size reduced 12/1/89.)
Pages 42, 43 (Content revised previously.)

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THE CHEMICAL QUALITY OF WATER IN
CONSERVATION AREA 2A AND ASSOCIATED CANALS

ABSTRACT
(Revised)

1. This study is the first detailed water-chemistry study within a conservation area. Chemical data was also collected during two months of the wet season from canal water flowing out of the agricultural area. During the eleven month period of investigation from October 1972-August 1973, 300 water samples were collected and over 2700 analyses were performed.

2. Hillsboro and North New River Canal water nutrient levels during July and August exceeded the organic nitrogen concentrations of urban runoff reported in the literature. Canal water nutrient levels were equivalent to urban canal water nutrient concentrations measured by a 1973 USGS study in South Florida.

3. Canal and marsh water exceeded Florida State Pollution Standards for specific conductance. Data strongly suggests that this is a permanent condition. Hillsboro Canal water exceeded FWPCA and WHO standards for ammonia on July 31, August 8 and 14.

4. The drawdown of CA-2A, February 9 - July 1, 1973, had no determinable effect on the chemical composition of water refilling the CA-2A marsh.

5. Vegetation in the marsh absorbed the relatively high nutrient inputs introduced from canal inflows. Nutrients were at considerably lower levels in the marsh than in the canals even though sodium, chloride, and silica differed very little between marsh and canal; these relationships were true even for samples in the marsh collected close to the S-10 discharge gates.

6. Dissolved organic nitrogen and dissolved organic phosphate phosphorus concentrations did not vary significantly between canal and marsh suggesting that they are refractory and not available as a nutrient source for organisms.

7. The chemical complexion of Hillsboro and North New River Canal water is not significantly different, now, from what it was in the 1940's. Nitrate, alkalinity, chloride, sodium, specific conductance, and silica concentrations are, at present, within the range of values and in the same order of abundance as they were 30 years ago as determined by the U.S. Geological Survey. Values determined within this two month canal sampling period were at the high range of historical data.

8. A small northwestern section of CA-2A was unaffected by high conductivity and high chloride water prevalent over the rest of the area.

9. The order of abundance of inorganic ions for both canals and the marsh was bicarbonate (alkalinity) > chloride > sodium > SiO_2. The order of abundance for nutrients was different between canals and marsh. The labile nitrate and orthophosphate virtually disappeared after entering the marsh.

10. The concentrations of various ions showed linear relationships. Nitrate and nitrite concentrations in the Hillsboro Canal were linear during the July - August sampling period. Chloride and sodium in the Hillsboro Canal and CA-2A marsh exhibited a significant linear relationship suggesting little uptake by vegetation as the water passes from canal to marsh.

11. Nitrate rather than ammonia was the most prevalent form of inorganic nitrogen detected in canals during flow periods. Within the marsh ammonia exceeded nitrate in concentration.

PURPOSE AND SCOPE

The chemistry of water in CA-2A is a product of the modifying effects of lush vegetation, algal growth, rainfall dilution and evaporative concentration on water from an eclectic variety of sources. Water in Area 2 is derived from rainfall, seepage from CA-1, groundwater, agricultural drainage, and disbursements from CA-1. The water received by the Area 2A marsh from the ag-lands is prone to high nutrient contents because of decades of fertilizer usage and the nutrient rich nature of the Everglades peat. Groundwater in the agricultural region is highly alkaline and contains appreciable sodium and chloride due to connate water in a limestone bedrock.

The quality of water in CA-2A resulting from the complex interaction of multiple sources and modifying forces is important. The Pompano Beach-Fort Lauderdale area depends on water storage in CA-2A to recharge wellfields in times of stress. The maintenance of viable fish, wildlife, and waterfowl populations and a productive Everglades ecology depends on quality water.

The purpose of this research was threefold: First, to make a detailed examination of surface water quality within the CA-2A sawgrass marsh and in canals discharging water over the marsh. Second, to determine if the spring drawdown of CA-2A had any effect, beneficial or deleterious on water quality. Third, to examine relationships between various chemical constituents in the water.

Samples were collected from the CA-2A marsh and from adjacent canals which furnish water to the marsh. The Hillsboro Canal above the S-10

structures, the tailwater side of the S-10 structures, the S-10 discharge canal, the tailwater side of the S-7 pump station and canals adjacent to L-38E and L-35B were all sample sources.

This report covers the time period from October 11, 1972 through August 22, 1973. Canals were sampled only when water was actively flowing into CA-2A; for this reason they were sampled only during two months, July and August, 1973. Water was sampled from the marsh on the following dates:

October 11, 1972
November 16, 1972
February 13, 1973
June 26, 1973
July 17, 1973
July 31, 1973
August 8, 1973
August 14, 1973
August 22, 1973

During the course of this study approximately 300 samples were collected and 2700 analyses performed. A major sample collection was made on February 13, 1973, which was four days after the drawdown began. Samples were collected on June 26, which was two weeks after the lowest water stages were recorded. Samples were collected at various times during July and August as CA-2A rapidly refilled from rainfall and S-10 discharge. Approximately one-third of the samples were collected and one-half of the analyses were run prior to any discharge from S-10.

PREVIOUS WORK

Water quality information on CA-2A, Hillsboro Canal and North New River water is sparse. Parker, et al. (1955) performed yeoman service during the years 1941 - 1945 in analyzing canal and groundwater in South Florida. The Hillsboro Canal near Deerfield Beach and the North New River Canal near Ft. Lauderdale showed wide fluctuations in chemical composition and maximum ranges for chemical components which were relatively high. The Hillsboro Canal showed dissolved-solids concentrations ranging from 98 ppm - 868 ppm and $CaCO_3$ hardness ranged from 65 ppm - 388 ppm (Table 1). Bicarbonate rose as high as 442 ppm; chloride attained a maximum level of 285 ppm, and specific conductance reached 1560 µmhos/cm. Nitrate ranged from 0 - 2.4 ppm (.54 ppm as N). North New River Canal water was similar in composition. It contained dissolved solids ranging from 140 - 592 ppm; $CaCO_3$ hardness varied from 140 - 418 ppm; bicarbonate and chloride were as high as 384 and 148 ppm; specific conductance on occasion exceeded 1000 µmhos/cm. Nitrate ranged from 0-2.0 ppm (.45 ppm as N). Parker, et al. found, generally, that when discharge was high in the North New River Canal the concentration of dissolved matter was relatively low and when the discharge was low, the concentration was high.

Four factors were reported to cause the extreme fluctuations and the maximal values for dissolved ions. First, groundwater in the Everglades is highly mineralized (Table 3). The highly saline water is believed to be connate water, in part. High chloride, sodium and sulfate concentrations probably originate from relicit Pleistocene seawater which has never been

TABLE 1

CHEMICAL COMPOSITION OF HILLSBORO CANAL WATER NEAR DEERFIELD BEACH
(Parker, et al., 1955)

Analyses in PPM

Date of collection	Color	Specific conductance (K x 10^6 at 25 C)	Calcium (Ca)	Magnesium (Mg)	Sodium and potassium (Na + K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Nitrate (NO_3)	Dissolved solids	Total hardness as $CaCO_3$
1941											
Mar. 19	140	67.5	53	17	65	213	28	98	2.0	368	202
Apr. 23	100	61.7	52	13	85	196	21	97	.5	366	135
May 21	200	84.0	58	18	96	256	21	139	.5	459	219
July 3	220	60.0	52	12	58	210	14	83	1.0	323	179
Aug. 22	240	34.4	32	9.2	26	131	6.6	42	.8	180	118
Sept. 19	.....	36.3	29	8.1	35	130	6.6	48	1.1	192	106
Oct. 23	180	37.8	32	10	34	143	11	47	.4	205	121
Nov. 26	130	49.9	42	12	45	164	15	72	1.6	268	154
Dec. 26	110	65.4	52	15	69	217	22	100	.6	366	191
1942											
Jan. 22	100	17.8	22	1.6	14	69	6.4	20	.1	98	62
Feb. 19	110	78.4	62	14	83	239	25	12	1.0	482	212
May 7	180	35.7	32	9.2	26	122	5.3	48	.4	181	118
June 4	120	21.9	22	4.4	17	81	9.9	24	.1	117	73
July 9	180	22.0	22	5.5	14	84	3.3	25	.1	111	78
Aug. 7	240	99.4	72	23	98	314	21	148	.2	517	274
Sept. 3	180	59.0	56	17	33	205	14	71	.3	292	211
Oct. 7	160	114	89	27	114	365	42	167	2.4	620	333
Nov. 11	100	94.7	80	21	88	307	30	138	1.2	509	286
Dec. 10	90	94.4	85	21	86	329	31	129	1.6	516	298
1943											
Jan. 7	100	94.7	80	21	90	325	22	138	.2	509	286
Feb. 4	90	116	98	23	113	374	34	172	.5	625	339
Mar. 4	65	103	98	17	95	336	37	147	.2	560	314
Apr. 1	65	123	103	22	125	360	43	198	.3	669	348
May 6	80	120	104	22	121	377	36	188	.4	657	350
June 2	120	147	106	27	182	384	52	285	.0	841	376
July 7	90	144	106	26	166	395	47	255	.9	796	372
Aug. 5	186	115	102	29	104	442	21	152	.0	626	374
Sept. 2	170	105	99	26	86	394	34	134	.2	573	354
Oct. 7	300	51.2	55	13	30	190	16	60	.4	268	191
Nov. 2	240	59.3	54	15	43	194	16	80	.4	304	196
Nov. 30	190	113	25	7.4	12	72	5.6	38	.2	124	93
Dec. 31	150	52.2	46	12	40	156	12	79	.2	268	164
1944											
Jan. 31	120	79.4	70	15	74	242	23	123	.8	425	226
Feb. 29	82	103	99	17	97	334	33	156	.5	567	317
Mar. 31	66	94.6	82	18	92	288	39	144	.1	517	278
May 2	80	83.8	91	15	69	319	26	106	.1	464	288
May 31	90	131	92	26	147	388	34	216	.2	706	336
July 1	180	106	97	29	89	430	19	129	.2	575	361
1945											
May 26	160	156	121	21	186	412	57	280	.0	868	388

TABLE 2

CHEMICAL COMPOSITION OF NORTH NEW RIVER CANAL WATER NEAR FT. LAUDERDALE

(Parker, et al., 1955)

Analyses in PPM

Date of collection	Color	Specific conductance ($K \times 10^5$ at 25 C)	Calcium (Ca)	Magnesium (Mg)	Sodium and potassium (Na + K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Nitrate (NO_3)	Dissolved solids	Total hardness as $CaCO_3$
1941											
Mar. 19	150	78.7	82	27	56	324	37	94	2.0	458	316
Apr. 22	220	63.3	78	20	35	282	39	56	2.0	369	277
May 21	220	92.8	94	33	64	372	60	101	.8	536	370
July 3	320	42.9	52	13	19	182	16	41	.5	231	183
Aug. 1	360	27.7	42	8.5	.9	148	3.3	12	.2	140	140
Aug. 22	320	48.4	61	15	23	236	11	42	.8	269	214
Sept. 26	280	50.0	55	16	34	237	30	37	.4	289	203
1942											
Apr. 9	160	103	108	36	62	387	83	105	1.6	586	418
May 7	220	74.9	88	21	41	320	30	72	1.5	411	306
June 4	220	88.7	99	30	56	348	76	90	.4	523	370
July 9	360	31.9	46	7.4	5.0	160	3.7	15	.1	156	145
Aug. 6	240	79.0	90	24	37	329	44	63	.2	420	323
Sept. 3	220	84.2	93	29	36	315	70	69	.1	452	351
Oct. 8	180	94.4	106	33	48	368	81	83	1.8	534	400
Nov. 11	100	72.2	74	21	47	280	37	74	.4	391	271
Dec. 10	50	50.8	54	16	29	190	36	50	.4	279	201
1943											
Jan. 7	75	68.5	72	20	43	269	33	70	.4	371	262
Feb. 4	50	59.3	64	17	34	227	38	56	.2	321	230
Mar. 5	50	65.9	67	19	95	250	36	148	.5	489	245
Mar. 31	40	52.5	58	17	26	204	38	46	.4	286	214
May 5	40	51.9	60	16	23	203	34	45	.2	278	216
June 3	85	81.3	83	27	49	318	42	86	.2	444	318
July 8	120	104	106	36	67	384	78	116	.3	592	412
Aug. 5	150	95.2	94	31	64	362	50	109	.0	526	362
Sept. 2	160	75.1	82	24	20	300	38	78	.4	391	303
Nov. 30	90	58.1	79	16	21	268	26	44	.6	319	263
1944											
Jan. 7	80	53.5	67	16	23	232	26	46	.5	293	233
Jan. 31	70	55.2	76	16	14	248	23	42	.3	294	256
Feb. 29	85	64.2	91	17	23	312	22	49	.3	356	297
Mar. 31	62	62.9	84	16	28	286	29	51	.2	349	276
May 1	85	70.8	79	23	42	290	54	63	.2	404	292
June 1	50	54.5	60	14	34	220	29	50	.2	296	207
June 30	90	79.1	89	22	47	342	36	69	.2	432	312
1945											
May 25	45	58.8	60	15	42	222	40	58	.8	326	216
Sept. 21	280	74.6	100	26	14	262	107	43	.4	420	356

TABLE 3

CHEMICAL COMPOSITION OF NON-ARTESIAN GROUND-WATER IN WESTERN PALM BEACH COUNTY

(Parker, et al., 1955)

Well no.	Location	Date of collection	Depth (feet)	Temperature (°F)	Color	Specific conductance ($K \times 10^5$ at 25 C)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium and potassium (Na + K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Nitrate (NO_3)	Dissolved solids	Total hardness as $CaCO_3$
S- 350	Miami Locks Camp, U. S. Sugar Corp.	Sept. 23, 1941	66	.....	50	908	0.05	160	148	1,761	769	925	2,300	.....	5,670	1,008
S- 352	Belle Glade, State Prison Farm	Sept. 22, 1941	35	76	360	254	.05	114	83	371	776	295	340	13	1,598	626
S- 355	Belle Glade, 0.2 mile E. of Hillsboro Canal and 0.6 mile N. of State Hwy. 15	.....do.....	47	75	180	148	.05	124	50	130	484	149	169	9.6	870	515
S- 356	.....do.....	.....do.....	47	74	180	209	.05	118	50	276	520	181	340	7.5	1,229	500
S- 358	Ritta Village, U. S. Sugar Corp.	Sept. 23, 1941	36.4	.....	320	388	.25	225	145	452	725	579	670	.....	2,428	1,158
S-1188	State Hwy. 15 between Pahokee and Canal Point	Sept. 10, 1941	20	.....	140	92.2	.10	111	46	29	480	96	41	.0	560	466
S-1189	Pahokee, State Hwy. 15, 1.6 miles S. of Pahokee water tower	.....do.....	18	.....	520	543	.05	237	128	862	849	661	1,140	.....	3,450	1,118
S-1190	State Hwy. 80, 1 mile E. of Hillsboro Canal	.....do.....	45	.....	280	156	.10	84	61	159	582	77	177	.....	845	460
S-1201	State Hwy. 15, 0.8 mile S. of Martin County line	Sept. 12, 1941	14	.....	260	116	.10	166	64	94	952	66	23	.4	882	677
S-1202	State Hwy. 15, 0.9 mile N. of West Palm Beach Canal	.....do.....	20	.....	260	263	.10	80	130	372	1,319	25	308	.6	1,566	734
S-1203	State Hwy. 15, 3.8 miles N. of West Palm Beach Canal	.....do.....	13	71	220	143	.10	221	62	36	744	143	90	.2	919	806
S-1204	State Hwy. 15, 3.9 miles N. of West Palm Beach Canal	.....do.....	22	75	180	182	.33	201	143	38	609	537	80	2.5	1,302	1,090
S-1205	State Hwy. 15, 4.1 miles N. of West Palm Beach Canal	.....do.....	20	77	400	143	.10	166	90	29	765	127	62	.4	851	784
S-1208	State Hwy. 80, 0.4 mile E. of North New River Canal	Sept. 22, 1941	60	.....	60	138	.10	80	76	143	751	57	104	.1	830	512
S-1209	Torry Island, N. of Chosen	.....do.....	12.5	73	280	126	.10	152	75	42	740	77	65	1.2	777	688
S-1210	Belle Glade, 0.9 mile N. of Belle Glade water plant	.....do.....	20	80	280	127	.07	137	1.7	154	414	170	113	11	791	349
S-1211	South Bay, 200 feet N. of intersection of State Hwys. 80 and 25	.....do.....	20	.....	280	138	.10	160	67	91	588	320	49	.2	959	675
S-1212	South Shore Camp, 1 mile S. of State Hwy. 80 and 3 miles W. of State Hwy. 25	.....do.....	35.5	76	80	181	.15	80	90	229	622	370	123	.2	1,199	570
S-1215	Miami Locks, Plantation	Sept. 23, 1941	31	76	180	212	.07	44	59	398	621	319	265	.2	1,389	352
S-1216	Lake Harbor, at Atlantic Coast Line R. R. station	.....do.....	20	.....	360	103	.15	84	50	64	550	54	34	.3	557	415

completely flushed out of the Everglades area. Saline waters are found in wells located in five counties near the shores of Lake Okeechobee. They are related to the occurrence of muck soils and the low permeability of underlying muck and marl deposits. Generally, the dissolved solids increase with depth (Figure 1). At many places highly mineralized water lies only a few feet beneath the surface of the ground (Parker, et al., 1955).

The second factor causing wide variations in canal water composition is Lake Okeechobee water. Lake water has a beneficial effect on the canal water by diluting it, since Lake water contains fewer dissolved ions. Third, agricultural drainage is extremely high in dissolved solids (Table 4). Bicarbonate, chloride, sulfate and calcium levels may reach 649 ppm, 303 ppm, and 240 ppm, respectively. The fourth factor is sheet-flow surface water from the Everglades marsh. This water has a beneficial effect on water quality because it is low in dissolved solids and dilutes the canal water (Parker, et al., 1955).

Hyde (1965) indicated that the Hillsboro Canal intersects an area south of Lake Okeechobee where the principal aquifer is "highly mineralized". Grantham and Sherwood (1968) described the quality of canal and groundwater in Broward County. They showed that the water was calcium bicarbonate in type and ranged from hard to very hard. They found high chlorides in the lower part of the Biscayne aquifer in inland areas and a seasonal variation in dissolved solids of canal water; the mineral content of the water was lower during the rainy season but increased during the dry season because of the increase in the percentage of ground water in the canals and drainage from swampy inland areas.

FIGURE 1

VARIATION IN GROUNDWATER CHLORIDE WITH DEPTH

(Parker, et al., 1955)

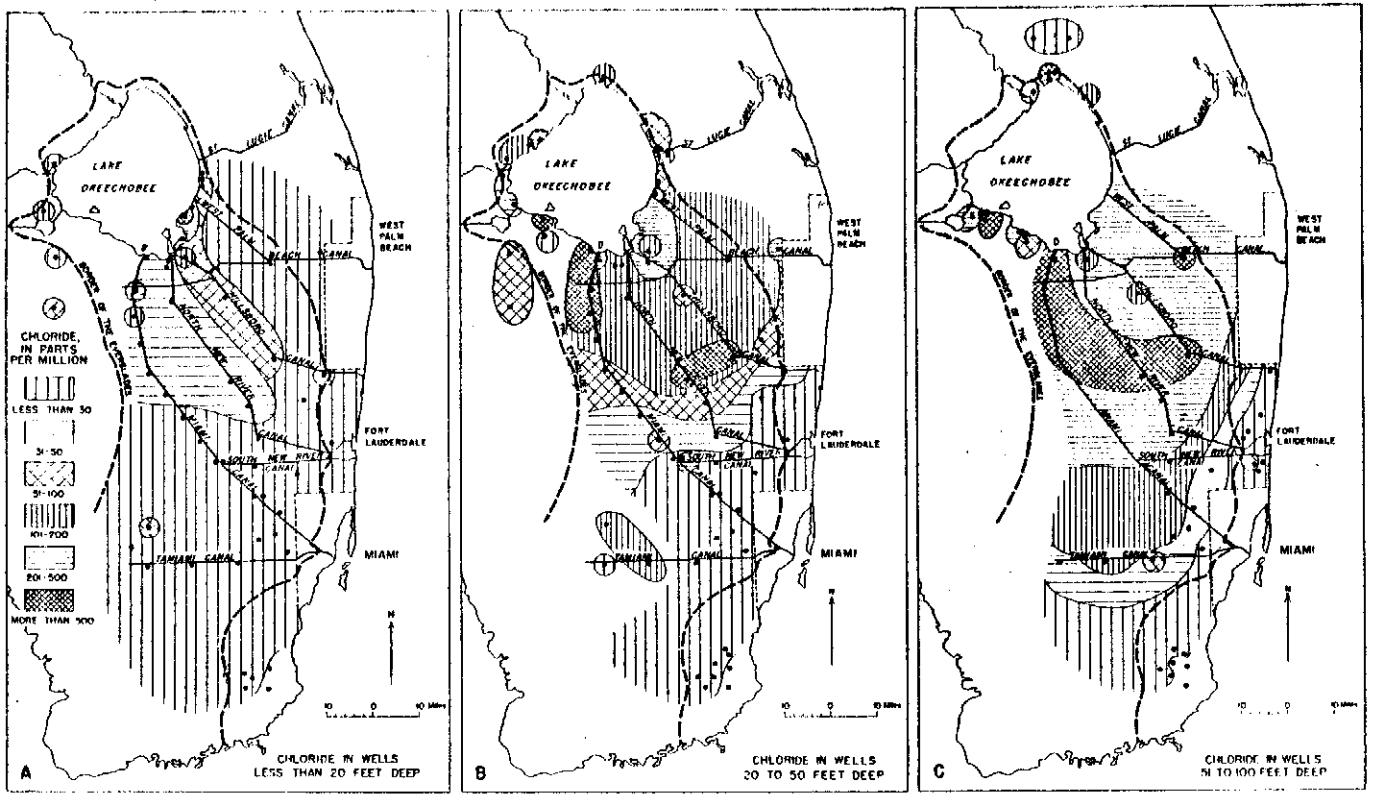


TABLE 4

CHEMICAL COMPOSITION OF AGRICULTURAL DRAINAGE
(Parker, et al., 1955)

Location	Date	Color	Specific Conductance μmhos/cm x 10^{-1}	Ca	Mg	Na + K	HCO_3	SO_4	Cl	NO_3	Dis. Solids	Total Hardness $CaCO_3$
Drainage ditch 2.4 miles southeast of Canal Point[1]	3/14/41	280	233	147	84	236	649	267	294	-	1,350	712
Drainage ditch 5.5 miles southeast of Canal Point[1]	do	440	240	178	97	231	728	308	303	-	1,480	843
Drainage ditch 8.7 miles southeast of Canal Point[1]	do	440	201	132	67	210	632	120	297	-	1,140	605
Drainage ditch at South Bay[2]	3/13/41	280	153	200	74	57	554	336	87	1.6	1,030	803
Drainage ditch at Okeelanta[3]	3/10/41	220	158	208	68	57	506	340	109	1.0	1,030	799
Drainage ditch 18 miles south of South Bay[4]	2/13/41	440	-	33	8.7	-	78	11	29	-	-	118
Drainage ditch 27 miles south of South Bay[4]	7/28/40	160	92.2	110	24	56	390	34	99	-	515	373
....Do...	2/13/41	220	-	29	9.0	1.0	76	9.5	28	-	114	109

[1]At pumphouse on State Highway.
[2]At pumphouse 0.1 mile N. or railroad bridge over North New River Canal.
[3]West of State Highway 25 and south of Bolles Canal.
[4]Along SCS dike west of State Highway 25.

Oddly enough, Parker, et al., attempted to show the same seasonal variation in dissolved solids within the major Everglades canals, but were confronted with data indicating higher dissolved solids during the wetter part of the year. Parker writes:

> "By May 1945, the accumulated deficiencies in precipitation for the year amounted to more than 11 inches in the Miami area. Because the summer rain ordinarily begins in late May or early June, it was decided to collect a series of samples of surface waters in the major Everglades canals prior to the rainy season. Another series was scheduled for collection in the early fall, which normally coincides with the end of the rainy season. It was anticipated that the samples collected in May would contain much larger amounts of dissolved salts than would the samples collected in September.
>
> "Contrary to expectation, the concentrations found in the September samples, for a majority of the sampling locations, were considerably higher than the concentrations found in the May samples. Because the two series of single samples could not possibly reflect all the changes that took place in the Everglades canals during the period, it is impossible to explain satisfactorily why most of the September samples were more concentrated than the May samples and, at the same time, to explain why the reverse was true for other sampling locations."

The Corps of Engineers study (1971) of water quality within the conservation areas, which took place during the October 1970 - February 1971 dry season, concluded that canal water north of the Park was nitrogen and phosphorus "low". Nitrate values from .01 - .10 ppm occurred 67 times whereas nitrate exceeded .10 ppm 22 times and .20 ppm 8 times. Orthophosphate was highly variable in amount and extremes ranged from .001 ppm to .102 ppm. Values of .01 or less were recorded 68 times in the 89 samples. The most frequent nitrogen to phosphorus ratios were from 5:1 to 20:1 (N/P).

The Corps report briefly analyzed historical data from the Conservation Areas of which 90% of the data were included in the period 1950 to present. Historical data showed that specific conductance, bicarbonate, calcium, nitrate, and orthophosphate have exhibited wide fluctuations rather than any strong trends. Northern stations showed poorer quality water than southerly canal stations. Two of their historical data points were of interest to this study: Hillsboro Canal at S-6 and Diversion Canal at S-143. The S-6 data is relevant to this study because water passing through the structure may be fed into CA-2A through the S-10 structures. Data for these stations are shown below:

Historical Data
Values for Percentile Indicated

	Sp. Conductance (μmhos/cm-25°C)			Nitrate (ppm as NO_3)		
	10	50	90	10	50	90
Hillsboro Canal at S-6	491	781	1114	.39	1.55	4.36
Diversion Canal at S-143	450	738	1000	.00	.22	.89

The Corps study concluded that "the poorer quality water in the north is due to extensive agricultural activities in the area south and east of Lake Okeechobee. The quality improvement as the water moves south probably is due to dilution by rainfall and self-purification during the slow journey through the 'sea of grass'."

In a mass nutrient survey of south Florida surface waters in September 1970, a high water period, and again in March 1971, a low water period, Freiberger (1972) found no significant differences in phosphorus, ammonia, nitrate, and nitrite between the wet season and dry season. Ammonia was the most prevalent form of nitrogen detected. In wilderness areas such as Everglades National Park, Big Cypress Swamp, and the water conservation areas phosphorus was scarce and was detected at only 10% of the sites sampled during the wet season and averaged about .01 mg/1 $P\text{-}PO_4$. During the dry season, the concentrations averaged about .07 mg/1. Five "gator hole" sites exhibited values between .18 - .67 mg/1 $P\text{-}PO_4$ because of accumulated waste from concentrated fish and aquatic animals. The dry season ammonia concentration in Everglades National Park averaged 1.3 mg/1 $NH_3\text{-}N$, but the water conservation areas generally averaged .15 mg/1 $NH_3\text{-}N$. Nitrate nitrogen concentrations were generally negligible in both the wet and dry seasons. Nitrate showed little variation between wet and dry seasons and the concentration at most of the sites was below .20 mg/1 $NO_3\text{-}N$. One marsh site and two canal sites were sampled in CA-2A. The marsh site at the 2-17 gauge evidenced <.01 ppm total phosphate, <.07 ppm ammonia, <.01 ppm nitrite and nitrate during both wet and dry season sampling periods. The canal sites at S-11B and S-145 revealed <.02 ppm total phosphate,

<.10 ppm ammonia, <.01 nitrite and <.13 nitrate during both wet and dry seasons. Waller (1973) reported conductivities ranging from 885 - 1814 μmhos/cm in CA-2A on February 26, 1973.

McPherson (1973) revealed that concentrations of dissolved solids were higher in the northern part of the conservation areas, which included CA-2, than in the southern part. Conservation Area 2A expressed dissolved-solids concentrations between 500 - 600 mg/1 from four stations during the period 1970 - 1972 compared with concentrations of from 172 - 289 mg/1 at four stations in 3A over the same time period. McPherson indicated that high dissolved solids correlated with high intensity of agricultural practice. Concentrations of nitrogen and phosphorus varied more with season than with location. Most nitrogen was organic and most inorganic nitrogen was ammonia. Concentrations of total phosphorus in June, 1971, ranged from .02 - .22 mg/1.

Ranges of Averages for All Conservation Areas (McPherson, 1973).

Organic Nitrogen	.8 mg/1 - 4 mg/1
NH_3	.05 - .45 mg/1
NO_3	0.0 - 2.1 mg/1
Tot PO_4	.02 - .05 mg/1
NO_2	.005 - .07

Freiberger (1973) found that backpumping water into CA-3 through S-9 had the effect of decreasing dissolved oxygen by as much as 5.8 mg/1 and increasing ammonia as much as .26 mg/1 above S-9. He attributed the ammonia increase to the large ground water contribution that occurred with backpumping.

In summary, the following generalizations emerge from previously reported studies:

1. Groundwater in the Everglades is highly mineralized and dissolved solids increase with depth. Canal water and groundwater are hard to very hard in quality. Bicarbonate is the single most abundant ion.
2. Agricultural drainage and groundwater from land south of Lake Okeechobee contain relatively high levels of calcium, magnesium, sodium and potassium, bicarbonate, sulfate, chloride, nitrate, total $CaCO_3$ hardness, and dissolved solids. Specific conductance, likewise, achieves high values.
3. North and northeastern conservation-area water exhibits higher dissolved solids than southern conservation area water.
4. Historically, canal waters exhibit widely fluctuating levels of specific conductance, bicarbonate, calcium, nitrate, and orthophosphate rather than strong trends.
5. Some stations within the Conservation Areas exhibit a trend of high dissolved solids during the wet season. Other stations exhibit an opposite trend of high during wet and low during dry.
6. Average nutrient concentrations in South Florida inland waters do not show significant seasonal variation.
7. Nutrients vary more with season or water level than with location in the conservation areas.
8. Organic nitrogen is the most abundant form of nitrogen in the conservation areas. Ammonia is the most abundant form of inorganic nitrogen. Nitrogen forms exceed phosphorus forms in concentration.

HYDROLOGIC SETTING

GENERAL

The S-10 structures and S-7 pumping station input surface water into Conservation Area 2A. The North New River Canal which intersects CA-2A at S-7, drains 233 sq. miles of agricultural and pasture land (CSFFCD, 1953). Water issuing from the S-10 gates is composed of CA-1 rim-canal water derived from the Hillsboro Canal and various canals north and east of S-5A pumping station, and marsh water, which is close to rainfall in purity. The Hillsboro Canal, alone, drains 218 sq. miles of agricultural land (CSFFCD, 1953).

The flow of water as it passes from the S-10 structures towards the south is influenced by the gentle topographic slope of the area, hydraulic gradients, and biotopographic features. Various vegetational communities are probably more effective than regional slope in controlling the actual flow path of water because the topographic gradient is only .30 foot/mile between S-10C and S-11B. At low water, sawgrass ridges probably impede the flow of water and sloughs act as friction-free areas which ease the flow of water south.

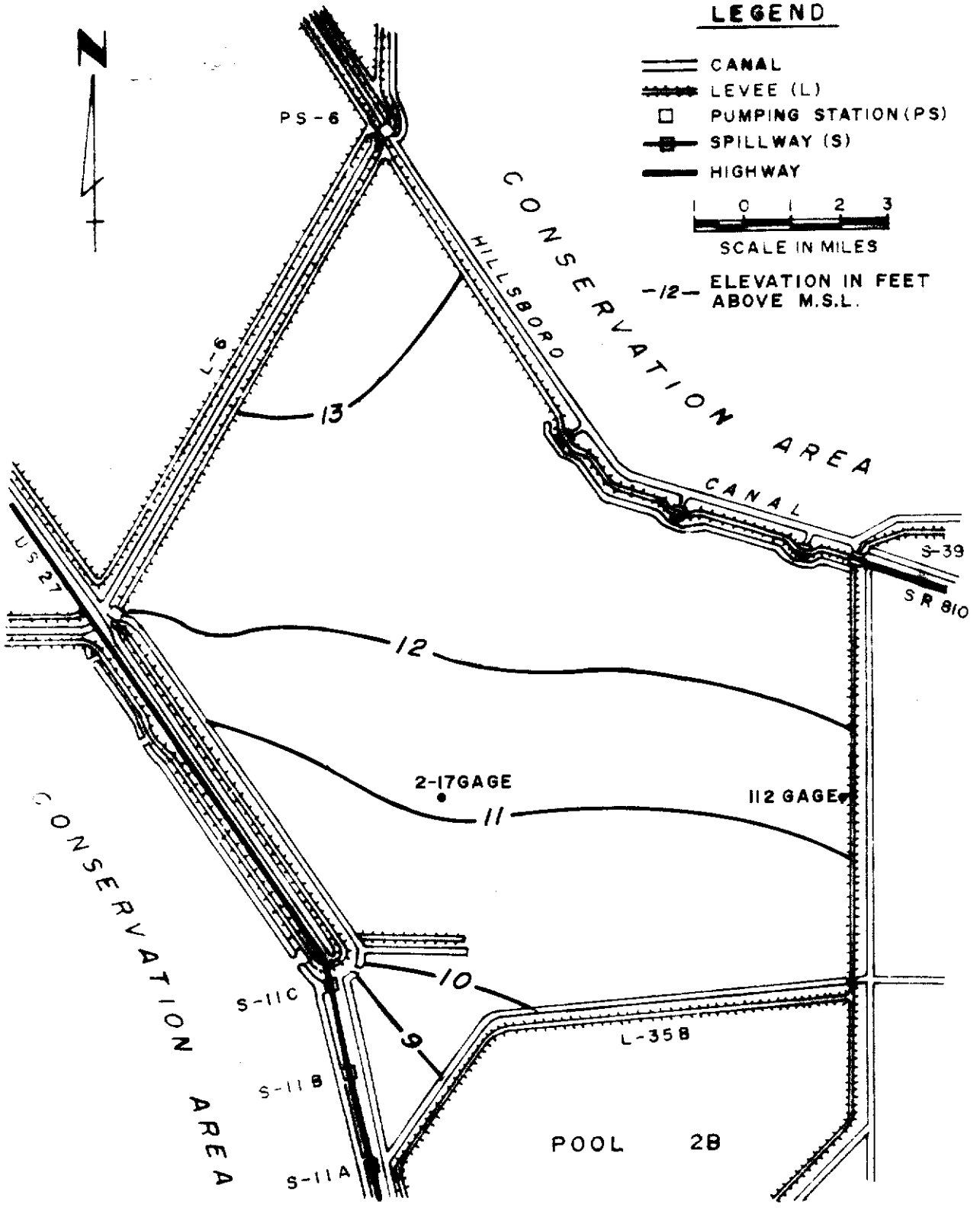
Independent sloughs within CA-2A act as independent lake-like basins at very low water levels. Peat ridges effectively cut off flow from one slough to another. The peats of the Everglades have a low coefficient of permeability and water moves through them very slowly under low gradients. Parker, et al., (1955) reported that in a test pit five feet square by three feet deep ground water seeped in so slowly that the "pit" could be emptied by slow bailing with a pint can," even though the water table was

one foot below the surface.

The triangular northern-most section of CA-2A, which is topographically higher than the rest of the area (Figure 2) receives input from rainfall, seepage and probably some flow from S-10D. Hydraulic gradients may cause water to flow a short distance into the topographically higher area of CA-2A. Tailwater levels at the S-10 gates may exceed 14.2 feet thereby setting up a downhill movement of water towards the north. Figure 3 shows a conductivity gradient for surface water in the extreme northern section of CA-2A. The Hillsboro canal on the east side of L-39 contains high conductivity water. Since this area is relatively far away from S-10D and upslope from the latter structure, this gradient probably represents seepage under L-39 which is progressively diluted with rainwater with increasing distance west from the levee.

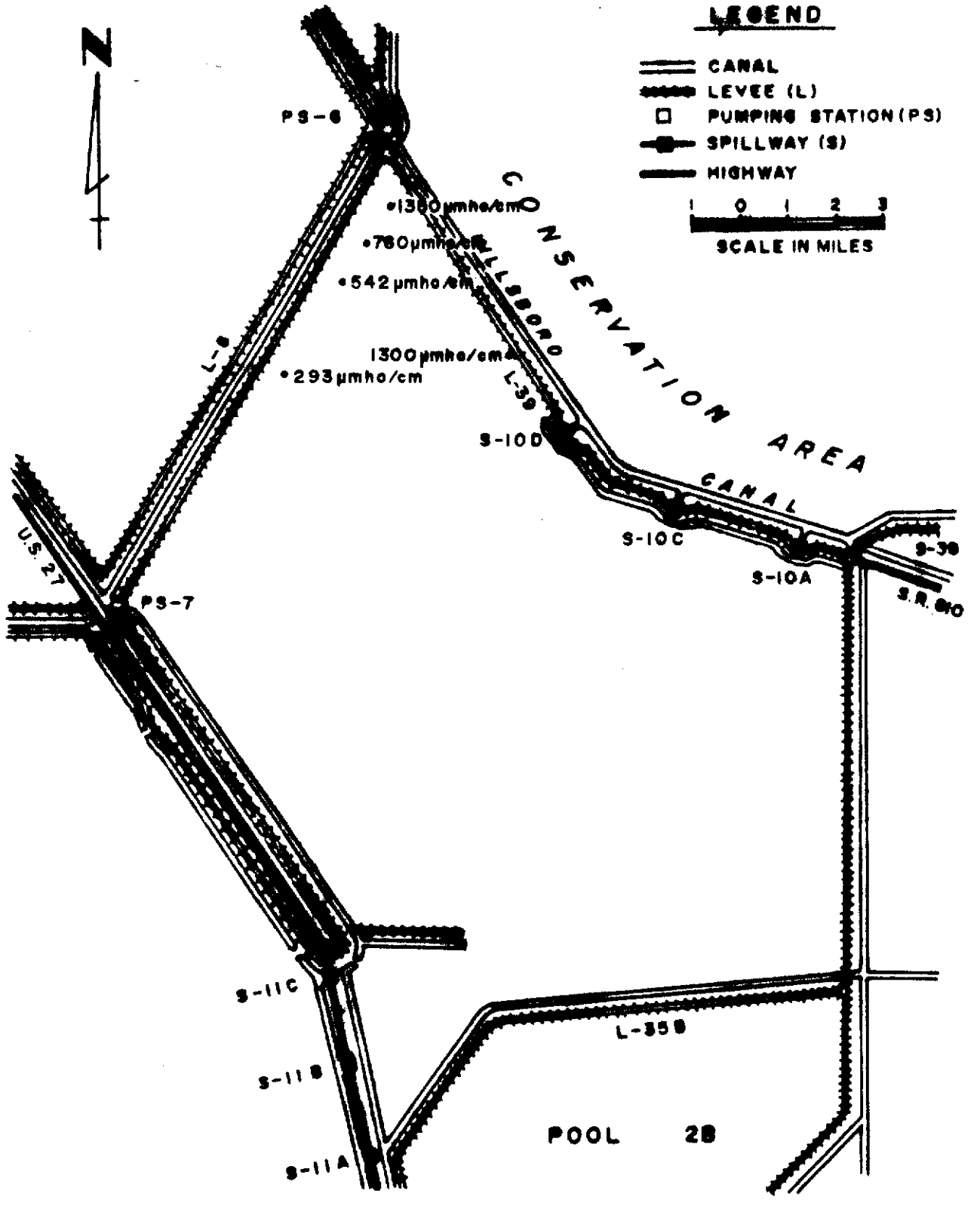
Evidence of seepage has recently been found between S-10A and S-10C. On January 29, 1974, a specific conductance value of 3240 μmhos/cm was measured one-eighth mile south of the discharge canal between 10A and C. Water in the discharge canal gave a specific conductance of 1660 μmhos/cm. On November 27 and December 17 this same marsh site gave conductance readings of 1940 and 2550 μmhos/cm, respectively. These values are high even for canal water and suggest the influence of seepage laden with groundwater.

Seepage out of CA-2A is a function of the underlying sediments and bedrock geology. Seepage out of CA-1 and CA-2A is relatively low compared with CA-2B and CA-3 for several reasons: 1) the peat sediments are thicker in CA-1 and CA-2A 2) clay sediments underlie peats and overlie bedrock in parts of CA-2A 3) bedrock in the Ft. Thompson formation changes from impermeable marls and dense fresh water limestones to solution-



TOPOGRAPHY OF CONSERVATION AREA 2A

FIGURE 2



CONDUCTIVITY GRADIENT ADJACENT TO L-39
SEPTEMBER 17, 1973

FIGURE 3

riddled limestone and calcareous sandstone from north to south in the area.

Seepage rates for L-35B and L-36 north of the Pompano Canal were originally computed by the Corps of Engineers at 4 cubic feet per second per mile per foot of head (CSFFCD, 1958); however, 2 cfs/mile foot is the current seepage factor in use. Seepage from CA-2A on a monthly basis is approximately 3 - 49% of a given storage value for the beginning of the month (Gleason, personal files, 1973). Percent seepage correlates inversely with storage. A wet year will result in a small percentage loss from storage via seepage but a large absolute loss of water. Water releases are made into Conservation Area 3A through the S-11 structures, into the Pompano Canal through S-38, and into the North New River Canal through S-143 and S-34. Disbursements to the coastal areas raise ground water levels in the Dixie, Prospect, and Pompano well fields, serving the Pompano Beach - Fort Lauderdale area (Leach, et al., 1972).

Releases to 2B through S-144, 145, 146 occur only infrequently. During the 12 year period 1961-1973, these structures discharged only 150,000 acre-feet of water into 2B.

The 1973 Drawdown

The drawdown of CA-2A was an attempt to thoroughly dry out CA-2A and thereby compact a thick flocculent "gyttja" which had accumulated over the bottom. The drawdown was begun on February 9, 1972 at a storage of 95,000 acre-feet as reported by the Corps of Engineers. The S-11 structures were kept open during each month except May. S-38 was opened periodically during March, April, May and June. The S-34

gates were periodically raised during April, May, and June. At the lowest point of the drawdown, June 7, 1973, the stage levels at the 2-17 and 112 gauges (Figure 2) were 10.41' and 8.04', respectively. The water table at the 2-17 and 112 gauges was .6' and 3.5', respectively, below the peat surface.

The lowest storage, which occurred on June 7, 1973, approximated 5,000 acre-feet as calculated by both the FCD Hydrology Department and the Corps of Engineers. Water was located in three places: small depressions filled with water in sloughs west of L-36, S-10 discharge canal, and in the peripheral canals inside CA-2A. Calculations indicated that free water should have existed in a small pocket adjacent to the S-11 structures. A flight over the area at the height of the drawdown revealed that free water did not exist in this area but water in this area may have been disguised as a thick hydrosol composed of water plus gyttja.

July rains and discharge from S-10 rapidly filled CA-2A during July. The S-10 structures were opened on July 24 and by the end of the month, storage had increased to a capacity six times the storage recorded on July 1. The entire 173 sq. miles was submerged by July 31 as revealed by helicopter survey while water sampling.

METHODOLOGY

Samples were collected by helicopter at a rate of 25 samples/2 hours. Specific conductance measurements were performed in the field. The water was immediately filtered at the time of collection through a .45μ filter, put into polyethylene bottles, and iced down in a dark box. Samples collected at pump stations or structures were collected on the discharge (tailwater) side. S-7 samples were collected several times a week, refrigerated at the station, and filtered when brought to the FCD laboratory on Monday and Thursday.

SiO_2, chloride and nutrient (nitrogen and phosphorus) analyses were performed using a Technicon Autoanalyzer. Total phosphate digestion utilized persulfate and total nitrogen digestion utilized Kjeldahl digestion. Alkalinity was determined by acid titration. Specific conductance was analyzed using a Hydrolab Surveyor conductivity meter and cell.

Samples were analyzed within a week - 10 days for alkalinity, chloride, sodium, SiO_2, orthophosphate, dissolved organic phosphate, nitrate, nitrite, ammonia and dissolved organic nitrogen. Early in the study (October and November) not all of these analyses were performed on every sample. Analyses are reported as ppm for chloride, sodium and SiO_2. Nitrate, nitrite, ammonia and dissolved organic nitrogen are given as ppm elemental nitrogen (N); orthophosphate and dissolved organic phosphate are likewise reported as ppm elemental phosphorus (P). Alkalinity and conductivity are reported as milliequivalents/liter and micromhos/cm-25°C, respectively.

USGS Standards #40 and #43 (July 20, 1973) were analyzed to check FCD working standards. The FCD analytical results with respect to analyses presented by 45 other laboratories are:

Ion	USGS Std. No.	% Deviation from mean of all laboratories	Within 95% confidence internal
SiO_2	40	.2	yes
Na	40	7.1	no
Cl	40	8.6	no
NO_3-N	40	5.1	yes
SiO_2	43	.7	yes
Na	43	10.3	no
Cl	43	1.9	yes
NO_3-N	43	0.9	yes

Accuracy is equal to precision for all analyses. For all the aforementioned analyses the accuracy and precision is taken as $\pm$ 5% of the amount present except for alkalinity and conductivity. For the latter analyses, the accuracy and precision is $\pm$ 10%.

Random samples were collected in many of the surveys. Random locations were selected by placing a grid with a 1/2 mile spacing over a map of CA-2A and using a two digit table of random numbers to locate points. The time of flight from a known point at 60 mph on a predetermined course was used to locate points in the field.

Linear regression curves between chemical parameters were calculated using the equations:

$$A = \Sigma XY - \frac{\Sigma X \Sigma Y}{N}$$

$$B = \Sigma X^2 - \frac{(\Sigma Y)^2}{N}$$

$$C = \Sigma Y^2 - \frac{(\Sigma Y)^2}{N}$$

$$Y = aX+b$$

$$a = \frac{A}{B} \qquad b = \frac{\Sigma Y - a\Sigma X}{N}$$

Pearson product-moment correlation coefficient = r

$$r = \frac{A}{\sqrt{B \cdot C}}$$

This correlation coefficient varies between plus one (+1) and minus one (-1). A+1 value for the coefficient indicates a perfect direct linear correlation of data points with a straight line. A -1 value for the coefficient indicates a perfect inverse linear correlation of data points with a straight line. A value of zero (0) indicates no correlation between data points and the straight line computed by linear regression equation. Values of the coefficient less than -.9 or greater than +.9 were considered significant in this study.

DATA

Sample location and chemical composition maps for most all of the sampling surveys are located in Appendix I. Tabulated chemical data are shown in Appendix II. The average chemical composition of both canal and marsh water for all sampling excursions is shown in Tables 5, 6, 7 and 8. Linear regression analyses for samples collected at S-7 during July are expressed in Table 10. Linear regression analyses for samples collected in the Hillsboro Canal adjacent to the S-10 structures during July and August are displayed in Table 11.

Canal and marsh water samples are grouped in Table 9. The means of all canal and all marsh water analyses are averaged to represent a single mean for each chemical constituent. The water chemistry is divided into nutrient and non-nutrient categories.

Marsh water chemistry before and after the drawdown is exhibited in Tables 12 and 13. Values in these tables represent the averages of mean concentrations of each chemical parameter for various sampling days.

Conservation Area 2A rainfall and stage levels at the 2-17 gage for the period November 1972 - August 1973 are shown in Figure 4. Discharges from S-7, S-38, S-143, S-144, S-145 and S-146, November 1972 through November 1973 are shown in Figure 5. S-10 and S-11 discharges for the time period November 1972 - August 1973 are presented in Figure 6.

TABLE 5

NON-NUTRIENT PARAMETERS IN MARSH WATER

Date	No. Samples		Cl ppm	Na ppm	SiO_2 ppm	Alk. meg/l	Conductivity micromhos/cm-25°C.
Oct. 11, 1972	43	Mean	121	-	18	-	-
		Std. Dev.	39		7.4		
Nov. 16, 1972	6	Mean	155		21.		
		Std. Dev.	23		2.3		
Feb. 13, 1973	32	Mean	156	109	10		
		Std. Dev.	67	40	4.7		
June 26, 1973	13	Mean	335	239	29		1349
		Std. Dev.	141	94	11		457
July 17, 1973	22	Mean	149	114	13	3.1	
		Std. Dev.	78	56	6.5	1.6	
July 31, 1973	30	Mean	126	96	14	4.3	755
		Std. Dev.	53	43	6	1.7	326
Aug. 8, 1973	17	Mean	187	148	21	5.4	
		Std. Dev.	22	18	4.7	.73	
Aug. 14, 1973	17	Mean	182	145	22	5.7	
		Std. Dev.	32	19	3.2	.8	
Aug. 22, 1973	29	Mean	177	124	22	5.2	1179
		Std. Dev.	37	29	3.6	.7	224

TABLE 6

NON-NUTRIENT PARAMETERS IN CANAL WATER

Date	No. Samples		Cl ppm	Na ppm	SiO_2 ppm	Alk. meg/l	Conductivity micromhos/cm-25°C.
July S-10 Discharge	5	Mean	185	166	19	5.4	
		Std. Dev.	22	28	3.5	1.9	
August S-10 Dis.	13	Mean	189	144	21	5.6	
		Std. Dev.	33	27	2.9	1.3	
July S-7 Discharge	39	Mean	147	100	17	7.4	
		Std. Dev.	10	11	2	.7	
July 17 L38E & L35B Canals	4	Mean	134	102	14	7.8	
		Std. Dev.	10	11	1.7	.4	
July 31 Hillsboro Canal in vicinity of S10 structures	9	Mean	175	140	19	5.9	1189
		Std. Dev.	29	29	4.4	1.0	154
July 31 L38E & L35B Canals	6	Mean	138	99	18	7.4	1088
		Std.Dev.	7	11	1.1	.3	87
August 8 Hillsboro Canal	8	Mean	202	159	24	6.1	
		Std. Dev.	18	20	4.8	.90	
August 14 Hillsboro Canal	8	Mean	194	136	21	5.8	
		Std. Dev.	23	15	1.3	.9	

TABLE 7

NUTRIENTS IN MARSH WATER

Date	No. Samples		NO_3-N ppm	NO_2-N ppm	NH_3-N ppm	DisOrgN ppm	O-PO_4-P ppm	DisOrg PO_4-P ppm
Nov. 16, 1972	6	Mean	<.002	<.004	-	-	<.004	-
		Std. Dev.	-	-	-	-	-	-
Feb. 13, 1973	32	Mean	≤.017 ≥.000	<.001	.06	-	<.001	<.01
		Std. Dev.	≤.026 ≥.000	-	.07	-		
June 26, 1973	13	Mean	<.008 ≥.000	<.010 ≥.006	.12	-	.006	-
		Std. Dev.	-	.017	.06	-	.013	-
July 17, 1973	22	Mean	.12	<.009 ≥.007	.05	.37	.003	.01
		Std. Dev.	.22	.012	.13	.14	.004	.01
July 31, 1973	30	Mean	<.063 ≥.058	<.025 ≥ .018	.03	2.2	.004	<.01
		Std. Dev.	≤.226 ≥.221	.060	.09	.5	.016	-
Aug. 8, 1973	17	Mean	<.008	<.008	<.01	-	.010	.01
		Std. Dev.	-	-	-	-	.018	.01
Aug. 14, 1973	17	Mean	<.008	<.008	.03	2.6	<.022 ≥.020	.012
		Std. Dev.	-	-	.08	.3	.034	.011
Aug. 22, 1973	29	Mean	<.008	<.008	.02	2.3	<.013 ≥.011	.016
		Std. Dev.	-	-	.04	.3	.021	.011

TABLE 8

NUTRIENTS IN CANAL WATER

	No. Samples		NO_3-N ppm	NO_2-N ppm	NH_3-N ppm	DisOrgN ppm	O-PO_4-P ppm	DisOrg PO_4-P ppm
July S-10 Discharge	5	Mean	1.8	.14	.34	2.3	.079	.01
		Std. Dev.	.9	.08	.30	1.2	.068	.02
August S-10 Dis.	13	Mean	.71	.089	.45	2.5	<.063	.02
		Std. Dev.	.68	.057	.26	.35	.041	.02
July S-7 Discharge	39	Mean	.92	.067	.33	1.3	.089	.01
		Std. Dev.	.63	.036	.12	.92	.12	.03
July 17 L38E & L35B Canals	4	Mean	.37	.027	.06	.36	.003	<.01
		Std. Dev.	.06	.012	.09	.10	.002	<.01
July 31 Hillsboro Canal in vicinity of S-10 structures	9	Mean	2.3	.21	.44	2.8	.100	<.01
		Std. Dev.	.9	.09	.29	.5	.063	<.01
July 31 L38E & L35B Canals	6	Mean	.72	.078	.23	2.2	.078	.02
		Std. Dev.	.39	.034	.14	.3	.049	.02
August 8 Hillsboro Canal	8	Mean	.68	.11	.54	-	.090	.02
		Std. Dev.	.37	.067	.27	-	.045	.02
August 14 Hillsboro Canal	8	Mean	.25	.058	.56	2.7	.053	.014
		Std. Dev.	.10	.019	.23	.9	.042	.031

TABLE 9

AVERAGES OF MEANS FOR ALL ANALYSES

Non-Nutrient Parameters in Canal Water
July - Aug. 1973

No. Samples	Cl	Na	SiO_2	Alkalinity	Conductivity
92	171	131	19	6.4	1139

Non-Nutrient Parameters in CA2A Marsh Water
Oct. 11, 1972 - August 22, 1973

No. Samples	Cl	Na	SiO_2	Alkalinity	Conductivity
209	176	139	19	4.7	1094

Nutrients in Canal Water
July - August 1973

No. Samples	NO_3-N	NO_2-N	NH_3-N	DisOrgN	O-PO_4-P	DisOrgPO_4-P
92	.96	.097	.37	2.0	.069	<.014 ≥.012

Nutrients in CA2A Marsh Water
Nov. 16, 1972 - August 22, 1973

No. Samples	NO_3-N	NO_2-N	NH_3-N	DisOrgN	O-PO_4-P	DisOrgPO_4-P
166	<.029 ≥ .022	<.009 ≥. 004	<.046 ≥.044	1.9	.007	<.011 ≥.008

TABLE 10

LINEAR REGRESSION EQUATIONS AND CORRELATION COEFFICIENTS FOR

JULY S-7 SAMPLES

	NO_3	NO_2	NH_3	DisOrgN	$O\text{-}PO_4$	Cl	Na	SiO_2	Alk
NO_3	x	y=.0338x +.0364 r=.59	y=.0963x +.247 r=.49	y=.722x +.591 r=.50	y=.162x -.049 r=.88	y=3.03x +143 r=.21	y=.546x +99.2 r=.03	y=.548x +16.1 r=.17	y=-.826x +8.17 r=-.80
NO_2		X	y=2.34x +.176 r=.68	y=18.8x +.0836 r=.72	y=1.67x -.0233 r=.46	y=53.1x +143 r=.18	y=56.2x +95.1 r=.18	y=33.1x +13.8 r=.54	y=-9.02x +8.12 r=-44
NH_3			x	y=4.97x -.437 r=.65	y=.228x +.0240 r=.18	y=41.0x +131 r=.43	y=70.7x +72.1 r=.68	y=16.1x +10.3 r=.77	y=2.52x +6.60 r=.21
DisOrgN				x	y=-.0738x +.302 r=-.22	y=4.74x +140 r=.32	y=6.22x +88.3 r=.36	y=1.91x +12.7 r=.61	y=-.635x +8.47 r=-.56
$O\text{-}PO_4$					x	y=-20.7x +151 r= -.28	y=-32.4x +105 r=-.37	y=-14.4x +23.7 r=-.0747	y=-5.10x +7.93 r=-.88
Cl						x	y=.760x -11.9 r=.70	y=.0788x +4.98 r=+.37	y=.00795x +6.21 r=.11
Na							x	y=.150x +1.62 r=.76	y=-.104x +19.8 r=-.11
SiO_2								x	y=.0275x +6.93 r=.08
Alk.									x

TABLE 11

LINEAR REGRESSION EQUATIONS AND CORRELATION COEFFICIENTS FOR
HILLSBORO CANAL SAMPLES AT S-10 STRUCTURES

JULY-AUGUST

	NO_3	NO_2	NH_3	DisOrgN	O-PO_4	Cl	Na	SiO_2	Alk	Cond.
NO_3	X	y=.0766x +.0353 r=.92	y=.0647x +.363 r=.24	y=.246x +2.23 r=.35	y=.0289x +.0478 r=.55	y=-.372x +180 r=-.01	y=4.83x +134 r=.16	y=.101x +20.1 r=.0261	y=.169x +5.92 r=.14	y=54.5x +1058 r=.43
NO_2		x	y=.988x +.324 r=.32	y=3.48x +2.11 r=.38	y=.291x +.044 r=.45	y=-1.24x +181 r=-.72	y=39.7x +135 r=.11	y=3.61x +19.6 r=.07	y=1.75x +5.93 r=.12	y=340x +1095 r=.22
NH_3			x	y=1.63x +1.87 r=.58	y=.116x +.0325 r=.58	y=78.9x +143 r=.70	y=53.1x +116 r=.48	y=11.6x +15.0 r=.76	y=2.61x +4.86 r=.56	y=396x +1001 r=.70
Dis OrgN				x	y=.0124x +.050 r=.17	y=23.7x +111 r=.53	y=8.98x +111 r=.23	y=2.27x +13.5 r=.57	y=.650x +4.50 r=.38	y=96.8x +906 r=.38
O-PO_4					x	y=202x +162 r=.34	y=257x +115 r=.47	y=37.0x +17.2 r=.51	y=9.44x +5.36 r=.41	y=1376x +1017 r=.52
Cl						x	y=.854x -16.3 r=.92	y=.0999x +2.33 r=.76	y=.00338 +5.62 r=.10	y=3.23x +666 r=.68
Na							x	y=.0816x +8.76 r=.63	y=-.0055x +6.93 r=-.14	y=2.78x +806 r=.63
SiO_2								x	y=-.001x +6.19 r=-.27	y=24.4x +700 r=.60
Alk									x	y=12.8x +1058 r=.10

TABLE 12

COMPARISON OF NON-NUTRIENT WATER CHEMISTRY
IN CA-2 MARSH BEFORE AND AFTER DRAWDOWN

Prior to the Drawdown

No. of Samples		Cl ppm	Na ppm	SiO_2 ppm	Alk meg/l	Conductivity micromhos/cm-25°C.
81	Average of Means	144	109	16	-	-

Post-Drawdown

No. of Samples		Cl ppm	Na ppm	SiO_2 ppm	Alk meg/l	Conductivity micromhos/cm-25°C.
128	Average of Means	192	144	20	4.7	989

TABLE 13

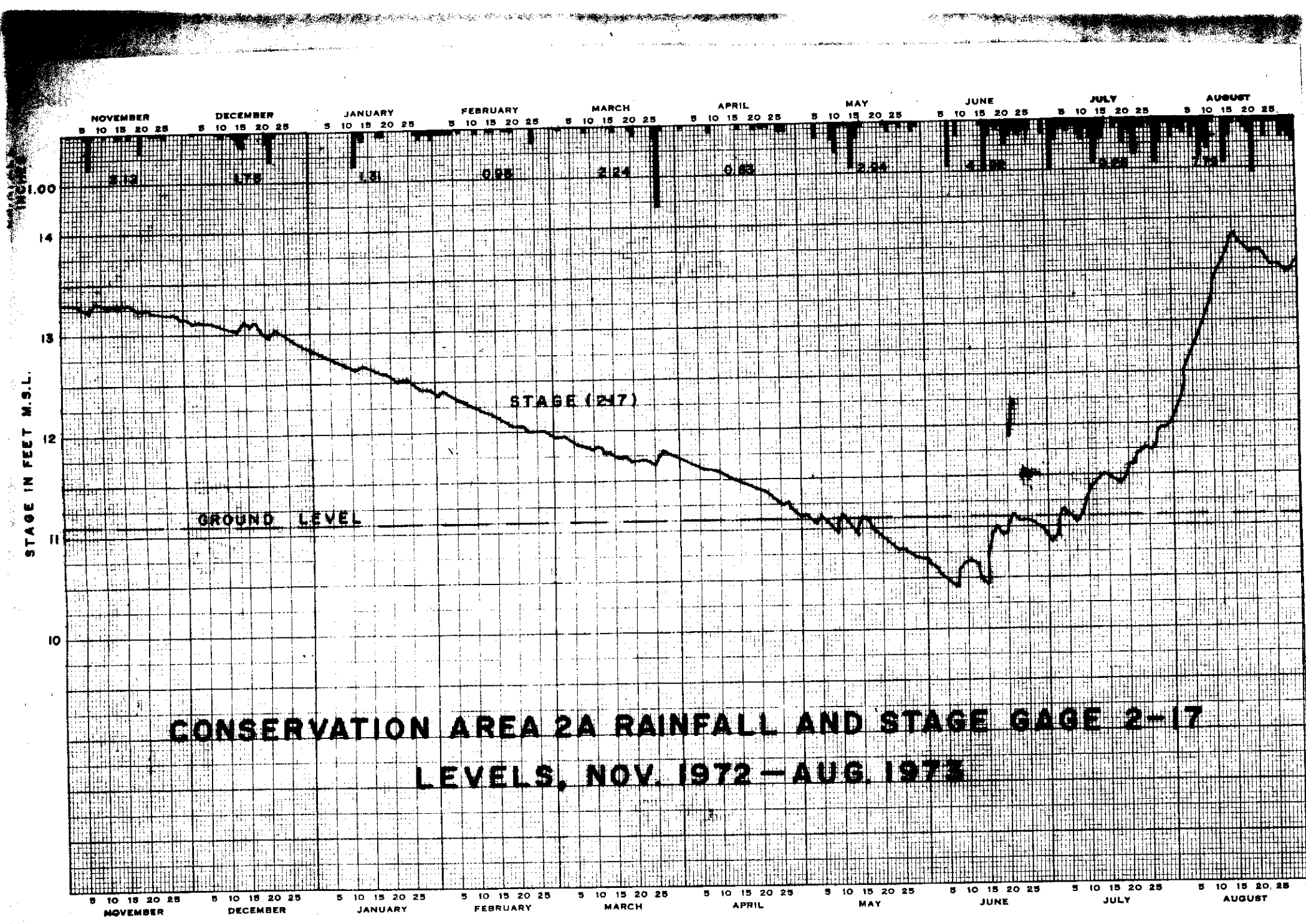
COMPARISON OF NUTRIENT WATER CHEMISTRY
CA-2A MARSH BEFORE AND AFTER DRAWDOWN

Prior to the Drawdown

No. of Samples		No_3-N ppm	NO_2-N ppm	NH_3-N ppm	DisOrgN ppm	O-PO_4-P ppm	DisOrgPO_4-P ppm
51	Average of Means	<.009 ≥.000	<.003 ≥.000	.06	-	<.003 ≥.000	<.01

Post-Drawdown

No. of Samples		NO_3-N ppm	NO_2-N ppm	NH_3-N ppm	DisOrgN ppm	O-PO_4-P ppm	DisOrgPO_4-P ppm
128	Average of Means	<.036 ≥.030	<.011 ≥.005	.04	1.9	.009	<.01 ≥.009



CONSERVATION AREA 2A RAINFALL AND STAGE GAGE 2-17 LEVELS, NOV. 1972 — AUG. 1973

FIGURE 4

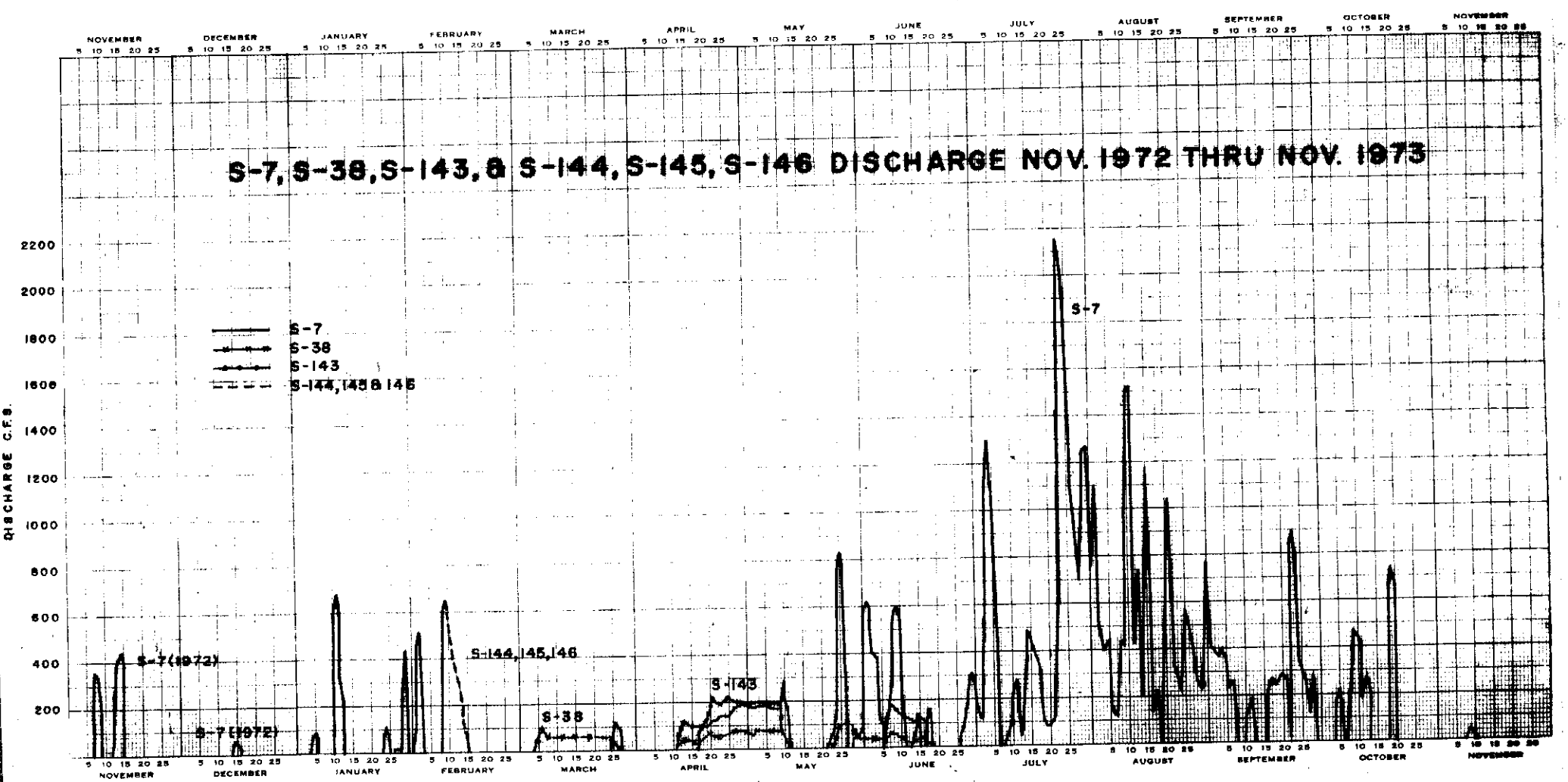
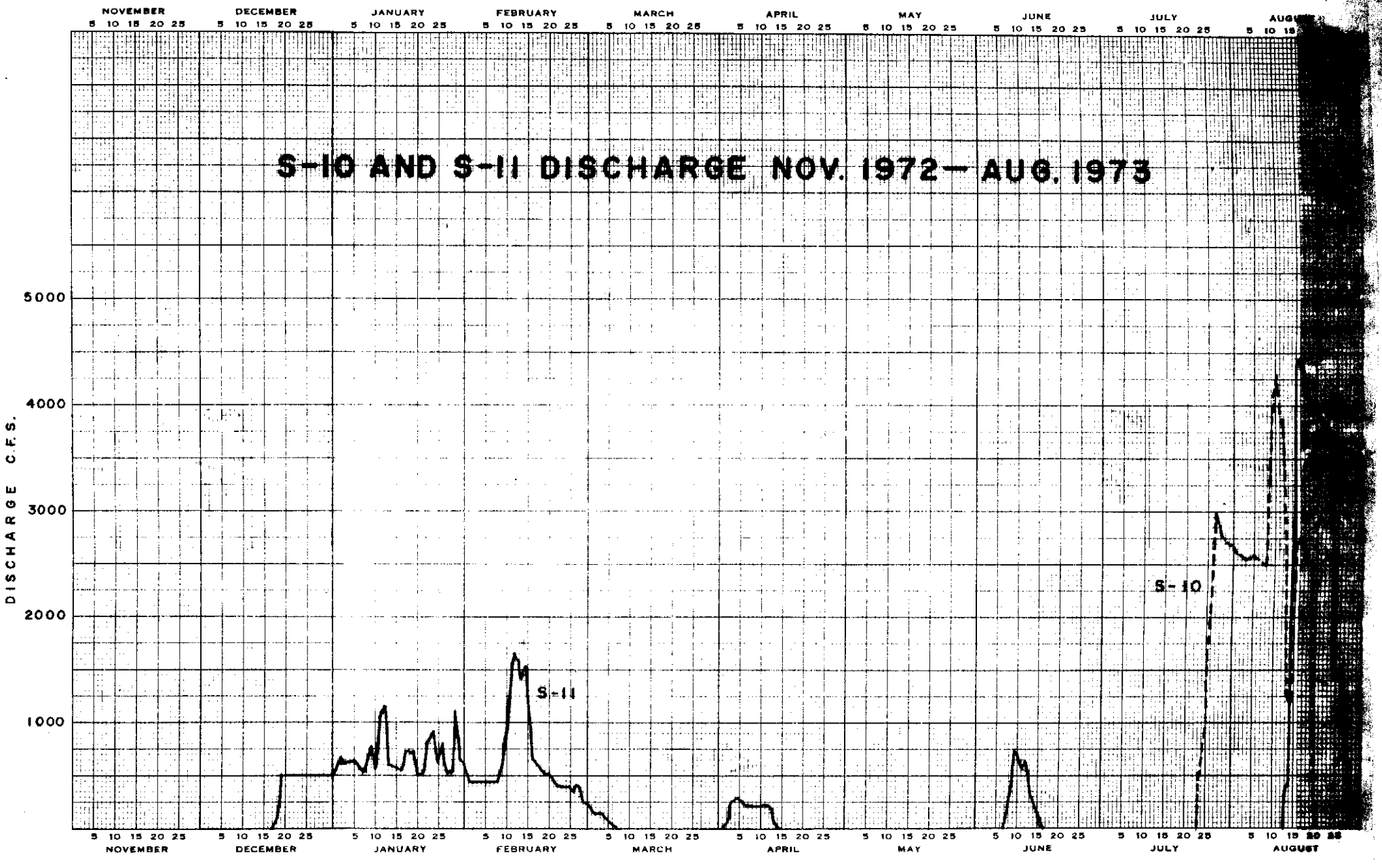

S-7, S-38, S-143, & S-144, S-145, S-146 DISCHARGE NOV. 1972 THRU NOV. 1973
DISCHARGE C.F.S.
2200
2000
1800
1600
1400
1200
1000
800
600
400
200
S-7
S-38
S-143
S-144,145&146
S-7 (1972)
S-7 (1972)
S-144,145,146
S-38
S-143
S-7
NOVEMBER
DECEMBER
JANUARY
FEBRUARY
MARCH
APRIL
MAY
JUNE
JULY
AUGUST
SEPTEMBER
OCTOBER
NOVEMBER

FIGURE 8


S-10 AND S-11 DISCHARGE NOV. 1972 – AUG. 1973
DISCHARGE C.F.S.
5000
4000
3000
2000
1000
S-11
S-10
NOVEMBER
DECEMBER
JANUARY
FEBRUARY
MARCH
APRIL
MAY
JUNE
JULY
AUGUST

FIGURE

DISCUSSION

QUALITY OF CANAL AND MARSH WATERS

The quality of marsh and canal waters as evaluated, using standards promulgated by four organizations, was good with two exceptions. Florida State Pollution Standards, Federal Water Pollution Control Administration Standards, United States Public Health Service Standards and World Health Organization Standards were used in the evaluation (Tables 14, 15, and 16). Water emanating from S-7 and Hillsboro Canal water adjacent to the S-10 structures exceeded Florida standards for specific conductance on July 31, the only day of conductivity measurement (Table 6); data obtained from the USGS (Personal communication, Bradley Waller, 1973) indicated excessive values on February 26, 1973. Specific conductance at these times was twice the maximum prescribed level. Excessively high conductivity is believed to be year-round and constant condition for water in canals feeding CA-2A.

On July 31, August 8 and August 14, Hillsboro Canal samples exceeded Federal Water Pollution Control Administration and World Health Organization Standards for ammonia (Appendix II). The significance of ammonia values in excess of the .5 ppm standard but below 1 ppm is questionable. The ammonia in rainfall sometimes exceeds standard values as shown in Table 17.

Specific conductance of marsh water parallels that of the canals since the canals provide a magnanamous amount of water to the marsh. Florida standards were exceeded on July 31 and August 22, the only two

TABLE 14

FLORIDA STATE POLLUTION STANDARDS

(403 F.S., Chapter 17-3)

The following water quality standards shall be the criteria for pollution when concentrations exceed following limitations:

Fluorides	1.4 to 1.6 (Class I)
Chlorides	250 mg/l
Turbidity	50 Jackson Units
Dissolved Oxygen	4.0 ppm
Dissolved Solids	1000 mg/l at any time
Specific Conductance	500 μ mhos/cm
Radioactive Substances	1000 μ curies
Cyanide or cyanates	none detectable
Copper	.5 mg/l
Zinc	1.0 mg/l
Chrominium	.50 mg/l hexavalent
Phenolic compounds	.001 mg/l
Lead	.05 mg/l
Iron	.30 mg/l
Arsenic	.05 mg/l
Oils and Grease	15 mg/l
pH	6.0 <8.5
Detergents	.5 mg/l
Mercury	none detectable

TABLE 15

SURFACE WATER CRITERIA FOR PUBLIC WATER SUPPLIES

(Federal Water Pollution Control Administration, 1968)

Constituent or Characteristic	Permissible Criteria	Desirable Criteria
Physical:		
Color (color units)	75	<10
Odor	-	Virtually absent
Temperature	-	-
Turbidity	-	Virtually absent
Microbiological:		
Coliform organisms	10,000/100 ml	<100/100 ml
Fecal coliforms	2,000/100 ml	<20/100 ml
Inorganic chemicals:	(mg/l)	(mg/l)
Alkalinity	-	-
Ammonia	0.5 (an N)	<0.01
Arsenic	0.05	Absent
Barium	1.0	do
Boron	1.0	do
Cadmium	0.01	do
Chloride	250	<25
Chromium, hexavalent	0.05	Absent
Copper	1.0	Virtually absent
Dissolved oxygen	≥4 (monthly mean) ≥3 (individual sample)	Near saturation
Fluoride	-	-
Hardness	-	-
Iron (filterable)	0.3	Virtually absent
Lead	0.05	Absent
Manganese (filterable)	0.05	do
Nitrates plus nitrites	10 (as N)	Virtually absent
pH (range)	6.0-8.5	-
Phosphorus	-	-
Selenium	0.01	Absent
Silver	0.05	do
Sulfate	250	<50
Total dissolved solids (filterable residue)	500	<200
Uranyl ion	5	Absent
Zinc	5	Virtually absent
Radioactivity:	(pc/l)	(pc/l)
Gross beta	1,000	<100
Radium-226	3	<1
Strontium-90	10	<2

TABLE 16

DRINKING WATER STANDARDS

Determination	USPHS	WHO
	Bacterial	
Coliform bacteria, per 100 ml	1.0	0.05[a] 1.0[b]
	Physical	
Turbidity, silica scale units	5	-
Color, cobalt scale units	15	-
Odor, maximum threshold number	3	-
	Chemical (mg/liter)	
Alky benzene sulfonate	0.5	-
Ammonia	-	0.5[a]
Arsenic	0.05[c]	0.2[a,b]
Barium	1.0[c]	-
Cadmium	0.01[c]	0.05[a]
Calcium	-	200[b]
Carbon chloroform extract	0.2	-
Chloride	250	350[a]
Chromium (hexavalent)	0.5[c]	0.05[a,b]
Copper	1.0	3.0[a]
Cyanide	0.2	0.1[a,b]
Fluoride	1.6-3.4[c]	0.5[a]
Iron	0.3	1.0[b]
Lead	0.05[c]	0.1[a,b]
Magnesium	-	125[a]
Magnesium + sodium sulfate	-	1000[b]
Manganese	0.05	0.1[a]
Nitrate, as NO_3	45	50[a]
Phenolic compounds	0.001	0.001[a]
(Potassium)		
Selenium	0.01[c]	0.05[a,b]
Silver	0.05[c]	-
(Sodium)		
Sulfate	250	250[a]
(Sulfur)		
Total Solids	500	1500[b]
Zinc	5.0	5.0[a]
	Radiological (pc/liter)	
Radium-226	3[c]	-
Alpha emitters	-	1[a,b]
Strontium-90	10[c]	-
Beta Emitters	1000[c]	10[a,b]

[a] WHO European Standards of 1961.
[b] WHO International Standards of 1958.
[c] Mandatory. Others are recommended by USPHS.

TABLE 17

AMOUNT AND NUTRIENT CONTENT OF RAINFALL AT ANDERSON-CUE LAKE, FLORIDA, 1968 (PUTNAM, et al., 1972)

Date	Amount[1] Inches	TON mg/l	NH_3-N mg/l	NO_3-N mg/l	o-PO_4 µg/l	t-PO_4 µg/l
2-19	1.00	—	0.46	0.40	230	—
2-26	0.25	—	0.23	0.94	20	—
3-4	0.35	—	0.80	0.26	25	—
3-11	1.20	0.57	0.86	0.24	18	—
4-15	0.65	0.67	0.33	0.27	2.2	—
5-6	0.45	0.64	0.10	0.30	28	—
5-13	0.75	0.33	0.0	0.15	20	—
5-27	3.35	0.11	0.02	0.05	——	—
6-24	6.65	0.24	0.02	0.14	9	30
7-5	4.00	0.39	0.05	0.09	10	30
7-25	4.65	0.01	0.01	0.08	8	—
8-2	0.85	0.50	—	0.29	——	20
8-19	2.10	0.34	0.14	0.22	33	70
9-3	10.85	0.07	—	0.09	——	20
9-16	4.30	0.07	0.11	0.16	5	—
10-11	2.65	0.12	0.05	0.11	12	—
10-19	3.70	0.11	0.21	0.04	4	—
11-11	3.60	0.23	0.07	0.05	25	30
12-9	2.25	0.54	0.18	0.11	18	—

days this type of analysis was performed.

The nitrate nitrogen and orthophosphate phosphorus in canal water did not exceed standards. However, water containing .96 ppm NO_3-N and .070 ppm O-PO_4 as P may constitute a threat to the ecology of the northern section of the conservation area even though these values are 3-5X average rainfall values. This caveat is supported by several observations. Periphyton survey during August, 1973, revealed that the heaviest and most abundant accumulations of blue-green algae were found adjacent to the S-10 structures. The periphyton closest to the structures was dominated by Microcoleus lyngbyaceous which appears only infrequently in "normal" Everglades periphyton. Rank cattail replaces sawgrass in a continuous band several miles deep along L39 south of the structures; this band shows up distinctly on ERTS photographs. Water hyacinth, Pistia, and Lemna blooms were most abundant adjacent to the structures.

Canal water emanating from the agricultural-lands was compared with urban runoff from various locations in the United States. Average nitrogen concentrations in canal water exceeded mean organic nitrogen levels in urban runoff. However, the phosphorus concentrations in urban runoff far exceeded the mean value of .070 ppm orthophosphate in canal water (Table 18).

Table 18
Nutrient Concentrations of Urban Runoff

Location	Soluble Phosphate as mg/L-P	Total Phosphate as mg/L-P	Organic Nitrogen as mg/L-N
Durham, N.C.[a] 1969-1970		.58[b]	
Ann Arbor[c] 1965	.8[d]		1.0[d]
Cincinnati 1962-1963	.8[c]	1.1[e]	1.7[c]
Tulsa[f] 1968-1969	1.15		.85

a. Bryan, E.H. 1970 Quality of Stormwater Drainage from Urban Land Areas in North Carolina, Water Resources Research Institute of UNC, Report No. 37.

b. Mean of seventeen samples.

c. Data from other studies reported in: Federal Water Quality Adminstration, 1970. Storm Water Pollution from Urban Land Activity. Water Pollution Control Research Series 11034 FKL of the FWQA.

d. Mean value.

e. Values reported in (a).

f. Data collected in study cited in (c). Fifteen sites examined.

Canal water nutrient concentrations during July and August were equivalent to urban canal water nutrient concentrations measured in a recent USGS study (Freiberger, 1973). The USGS data for the South New River Canal at S-13 (an urban area) are compared below with Hillsboro and North New River Canal nutrient concentrations.

	USGS Urban Canal Water	This study Hillsboro & N. New River Canal Water (July & August)
Ammonia (NH_3-N)	.450	.37
Nitrite (NO_2-N)	.033	.097
Nitrate (NO_3-N)	.28	.96
Organic Nitrogen (N)	1.41	2.0
Ortho Phosphate (PO_4-P)	.085	.070
Total Phosphate (PO_4-P)	.091	>.081 <.084

THE EFFECT OF THE DRAWDOWN ON WATER QUALITY

Predrawdown samples were collected on October 11, November 16, 1972, and February 13, 1973. All samples collected on June 26 and later were procured after the minimum stage of the drawdown and therefore reflect the post-dessication period.

Nitrate was approximately four times greater and phosphorus was more than twice as great after the drawdown than before. Increases of up to 40% were noted in non-nutrient parameters after the drawdown in comparison with predrawdown concentrations. The higher nitrate concentrations after the dry-out were due to one set of samples collected on July 17 which revealed a mean nitrate concentration of .12 ppm. These samples were taken from small pools just beginning to fill after the drawdown. Very likely the high nitrates were leached out of dried and mineralized peat; increased concentrations of all forms of nitrogen were described by McPherson (1973) as the result of the first summer rains flushing nutrients into ponded water.

The increased phosphorus values and slightly higher concentrations of chloride, sodium and silica appearing in the water after the drawdown were the results of several factors: 1) the refilling of the area with high nutrient and high dissolved solids water emanating primarily from the S-10 structures; 2) the absence of any dilution of the S-10 discharges by water already stored in the area; 3) biased sampling of evaporative concentrations of salts after the drawdown and an artifact of sampling close to the S-10 structures.

The experimental dessication of Lake Apopka bottom sediments, i.e., an experimental drawdown, has had favorable preliminary results with respect to the effects of sediment drying on refill water quality. Fox, et al. (1973) report:

> "Peat and muck sediments from Lake Apopka, Florida, have been allowed to dry in plexiglas columns and metal tanks in an effort to simulate the effects of lake drawdown. Variables used include depth of sediment, method of drainage, and drying time. Sediment parameters being monitored include nutrient forms, water loss, rate of consolidation, and plant germination. Following drying periods, the simulations are refilled and monitored for water quality using standard limnological techniques. Results to date show that consolidation varies with drying time, with fifty per cent consolidation after six months. Sediment changes have been largely a result of water loss, with little change in nutrient forms or amount of organic material. Preliminary indications are that nutrients are more readily available from undried as opposed to dried sediments."

The research of Fox, et al. suggests that compaction of the flocculent material in CA-2A should make nutrients in the bottom sediments less available to the overlying water.

RELATIONSHIPS AMONG VARIOUS DATA

A comparison of our two months of wet season canal data with previous work suggests that the chemical complexion of Hillsboro and North New River Canal water has changed little during the thirty-year period from the early 1940's to the young 1970's. The range of values found in this study are within the range of values found by Parker, et al. (1955) in 1941-1943 (Tables 19 and 20). Bicarbonate, chloride, sodium, silica, and nitrate are in the same order of abundance now as they were then.

Our canal data are towards the higher range of values found in historical data. A comparison of our data with historical analyses reported in the Corps of Engineers study (1971) for the Hillsboro Canal at S-6 and the Diversion Canal at S-143 indicate that our specific conductance and nitrate values exceeded 90th percentile values for both parameters at both locations (i.e., more than 90% of all historical samples had values less than our values). The highest nitrate concentration (as NO_3) reported by Parker, et al. was 2.4 ppm; this was equivalent to .54 ppm NO_3-N and was about one-half of the average NO_3-N concentration found in our canal study.

Differences in nitrogen values between previous work and this study are puzzling. Our <u>average</u> canal-water nitrate nitrogen values were considerably higher than Parker's but they were also 6-9X greater than <u>average</u> values reported in Freiberger's (1972) work and approximately 5-10X <u>average</u> nitrate values found in the Corps of Engineers study (1971).

TABLE 19

Chemical Composition of Hillsboro and North New River Canal Water During July and August 1941-1943 (Parker, et al., 1955)

Analyses in PPM

Hillsboro Canal Near Deerfield Beach

		Specific Conductance µmhos/cm	Sodium and Potassium	Bicarbonate	Chloride	Nitrate (NO_3)
1941	July	600	58	210	83	1.0
	Aug.	344	26	131	42	.8
1942	July	220	14	84	25	.1
	Aug.	994	98	314	148	.2
1943	July	1440	166	395	255	.9
	Aug.	1150	104	442	152	.0

North New River Canal Near Ft. Lauderdale

1941	July	429	19	182	41	.5
	Aug.	277	.9	148	12	.2
1942	July	319	5.0	160	15	.1
	Aug.	790	37	329	63	.2
1943	July	1040	67	384	116	.3
	Aug.	952	64	362	109	.0

TABLE 20

Chemical Composition of 10-Day Composite Water Samples from North New River Canal at 26-Mile Bend, 1941 (Parker, et al., 1955)

Analyses in PPM

	Sp. Cond. µmhos/cm.	Silica	Bicarbonate	Sodium	Chloride	Nitrate (as NO_3)
March 1-10	1100	20	382	77	119	2.2
March 11-20	985	16	356	74	115	1.3
March 21-24 28-31	1000	16	366	81	119	1.1
Apr. 1-8	977	15	360	79	118	1.2
Apr. 14-16 19-20	587	7.8	245	31	43	1.7
Apr. 21-27 29-30	938	16	358	70	98	1.1
May 1-3 5-9	986	16	363	74	112	1.5
May 11-13 16-17 19-20	920	17	358	65	95	1.9
May 21-31	1050	18	396	82	124	1.4
June 2,4-7, 11	1250	22	462	101	154	2.0
June 17-19 21,23	861	12	330	62	93	1.6
July 3-9	552	9.4	218	37	51	1.3
July 11-20	264	5.6	138	8.9	13	1.2
July 21-27 29-31	258	8.3	140	8.8	12	.8
Aug. 2-7	277	8.1	145	10	16	.7
Aug. 11-12 14-20	478	13	228	24	38	.6
Aug. 22-25 27, 29-31	774	18	326	52	76	1.0
Sept. 1-10	957	19	376	70	103	1.4
Sept. 11-13 16-20	1020	21	392	75	110	1.5
Sept. 21-26 28-30	722	14	267	47	69	2.2
Oct. 1-5	808	18	310	58	85	1.1

Nitrate rather than ammonia was the most prevalent form of inorganic nitrogen detected in our canal study. Both Freiberger (1972) and McPherson (1972) found ammonia as the dominant form of inorganic nitrogen. All aforementioned previous studies sampled largely from canals; the difference may be that in this study samples were collected only while the canals were actively draining the agricultural lands,whereas the Corps study occurred during the dry season and the USGS studies were long term averages. Organic nitrogen was the most abundant form of nitrogen found in canal and marsh water in this research; McPherson (1972) reached the same conclusion.

Nutrient concentrations in the marsh were considerably below those in adjacent canal water (Table 7). The highest average nitrate, nitrite, and ammonia concentrations in the marsh occurred at the beginning of wet season rains. Nitrate was highest, .12 ppm, on July 17. Nitrite was greatest, approximately .021 ppm, on July 31. The highest average ammonia concentration, .12 ppm, was measured on June 26 (Table 7).

Orthophosphate levels in the marsh were highest during high water periods of August probably because of S-10 discharge and the overflowing of nutrient-absorbing compartments near the discharge points; average orthophosphate values ranged from <.001 ppm - .010 ppm. Phosphate values approaching those found by Freiberger in residual ponds in Everglades National Park, .18 - .67 ppm PO_4-P, were never found in CA-2A.

Water in the CA-2A area is the calcium bicarbonate type, as mentioned in the previous literature. Alkalinity measurements clearly indicated this fact. Bicarbonate was the most abundant ion found in the analyses. Averages of the mean bicarbonate concentrations were 287 ppm

and 390 ppm for marsh and canal waters, respectively, using the conversion factor of 61 ppm HCO_3/meq-Alk (Table 9).

The high bicarbonate concentrations cannot be explained by entrapment of ancient seawater because bicarbonate is much higher than chloride in concentration. The bicarbonate is generally higher than that of seawater which doesn't exceed 28 ppm as elemental carbon or approximately 120 ppm as bicarbonate (Horne, 1969). The high bicarbonate is probably of indigeneous origin. Decaying peat probably facilitates the solution of the underlying limestone by furnishing acidic carbon dioxide gas. The action of the acid then converts insoluble $CaCO_3$ to soluble $Ca(HCO_3)_2$ (Parker, et al., 1955).

The Na/Cl weight ratio for Hillsboro Canal water and CA-2A marsh water varies between .76 and .85. The Na/Cl weight ratio for seawater is .55. Thus, if highly mineralized groundwater in the canals is derived from connate seawater, the water has probably undergone enrichment in sodium through a number of known processes (Leach, et al., 1972); (Parker, et al., 1955).

A comparison between marsh water nutrient levels and canal water nutrient levels indicated several interesting points. First, vegetation in the marsh is apparently absorbing the relatively high nutrient inputs introduced from canal inflows. Though sodium, chloride, and silica differ very little between marsh and canal, nutrients are at considerably lower levels in the marsh than in the canals (Table 9). Nitrate, nitrite, ammonia and orthophosphate in the marsh are one-thirtieth, one-twentieth, one-ninth, and one-eighth, respectively, of corresponding levels in canals. The disparity between canal and marsh water can be seen graphically in

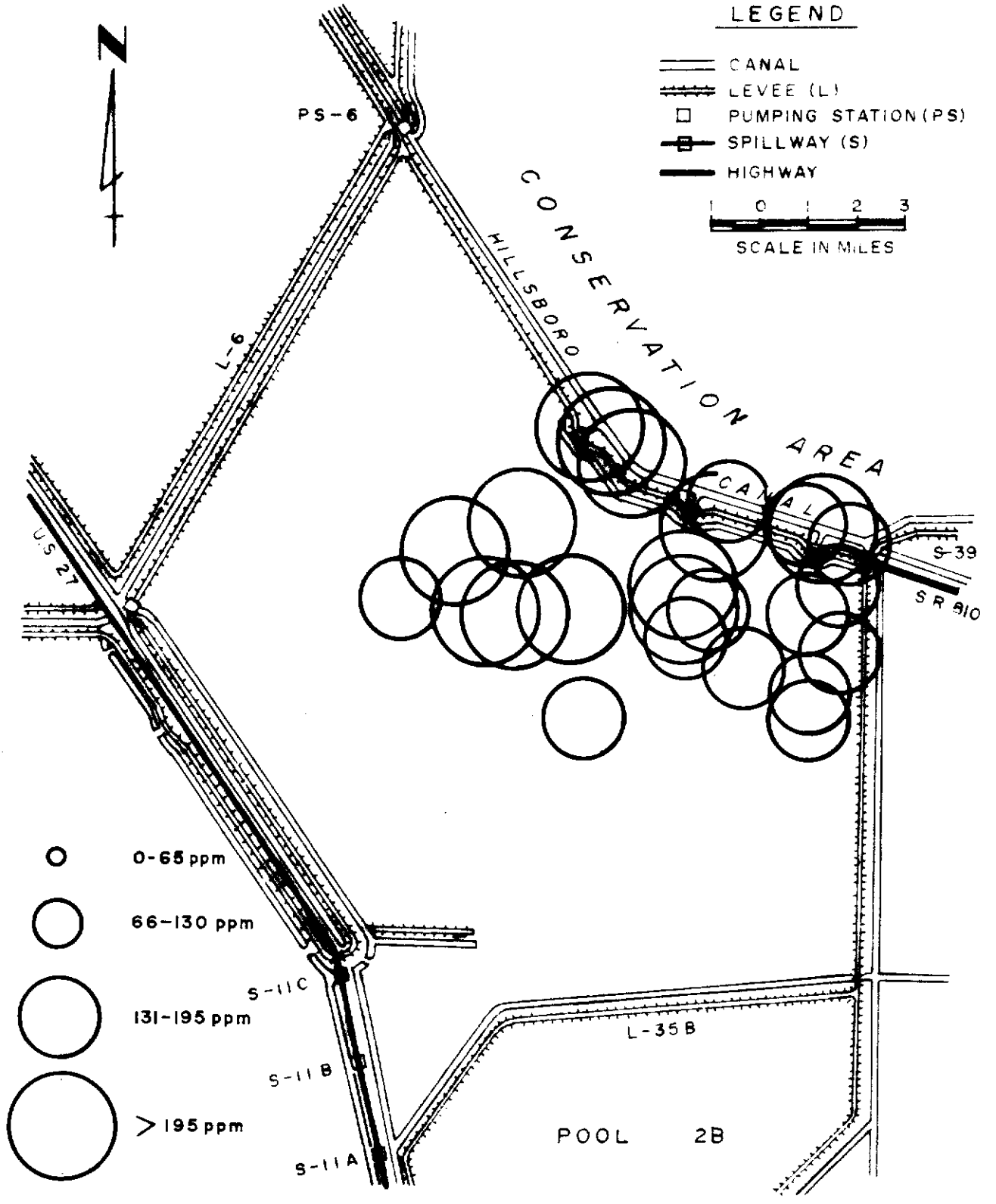
Figures 7 - 12; this disparity exists even after considerable flow from S-10. Second, dissolved organic nitrogen and organic phosphate phosphorus concentrations do not vary significantly between canal and marsh, suggesting that they are refractory and are not used as a nutrient source for organisms.

The order of abundance of fixed nitrogen compounds differed between canal and marsh. In canal water, the order of abundance was organic nitrogen > nitrate > ammonia > nitrite, whereas in the marsh, nitrate and ammonia exchanged places (Table 9).

Orthophosphate exceeded dissolved organic phosphorus more than fourfold in canal water but dropped to a near equal concentration within the marsh. The reason for this is clearly the uptake of orthophosphate by organisms; dissolved organic phosphorus appears to remain unchanged. (Table 9)

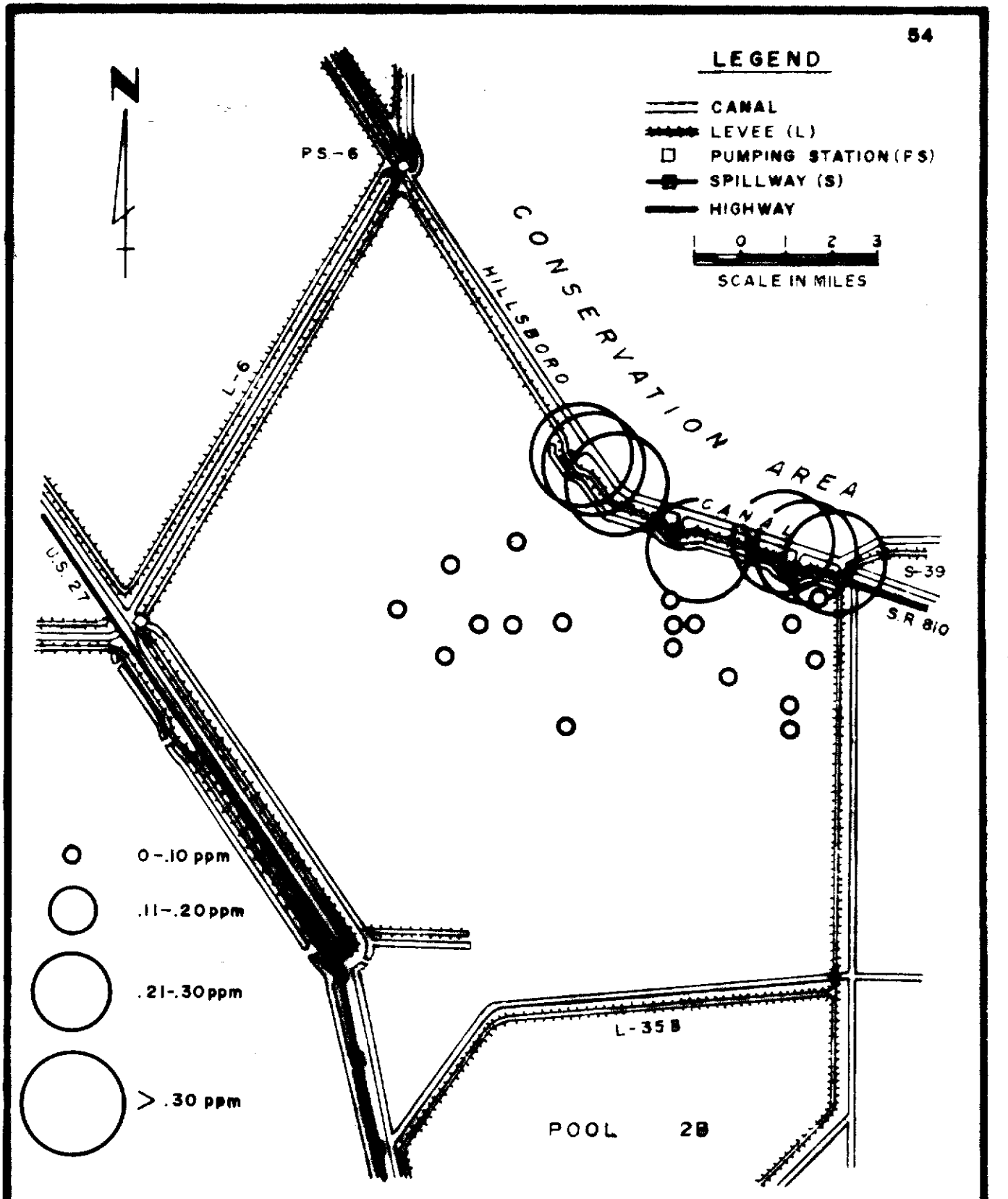
A significant linear relationship existed between nitrate and nitrite concentrations in Hillsboro Canal water during the July - August sampling period. The same relationship did not hold for water entering CA-2A through S-7 pumping station (Tables 10 and 11). The linear regression relationship is a function of either denitrification or nitrification reactions proceeding in the water on ammonia and nitrate derived from leached fertilizers and decomposing peat. The Everglades peats are nitrogen-rich and range from 2.7-3.8 N on a dry weight basis according to Bureau of Mines analyses (Table 21).

Chloride and sodium entering the marsh from the S-10 structures evidence a strong linear relationship (Table 11). This strong relationship is also found in the marsh as denoted by the following linear regression equations and high correlation coefficients:



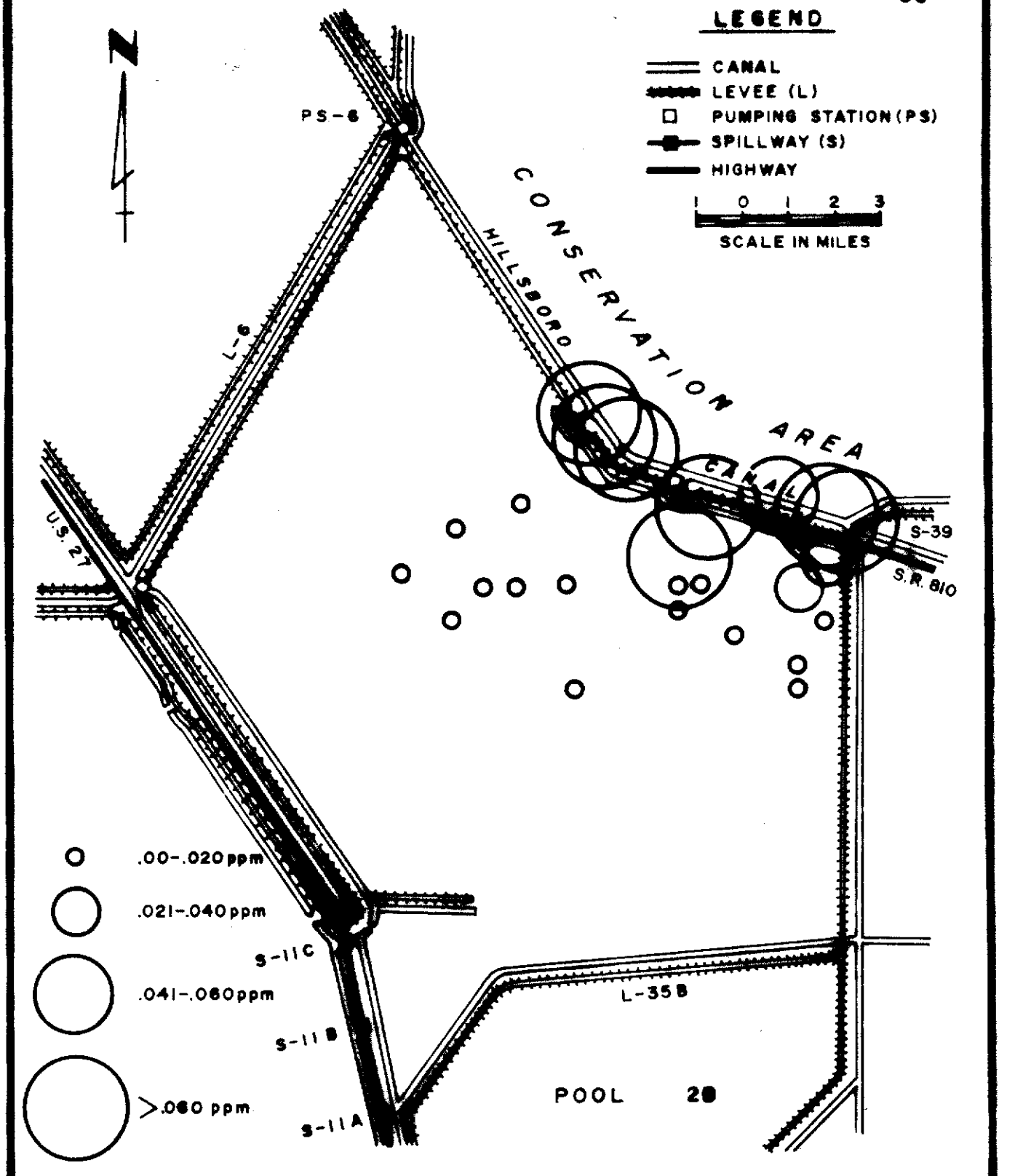
CHLORIDE CONCENTRATIONS
AUGUST 8, 1973

FIGURE 7



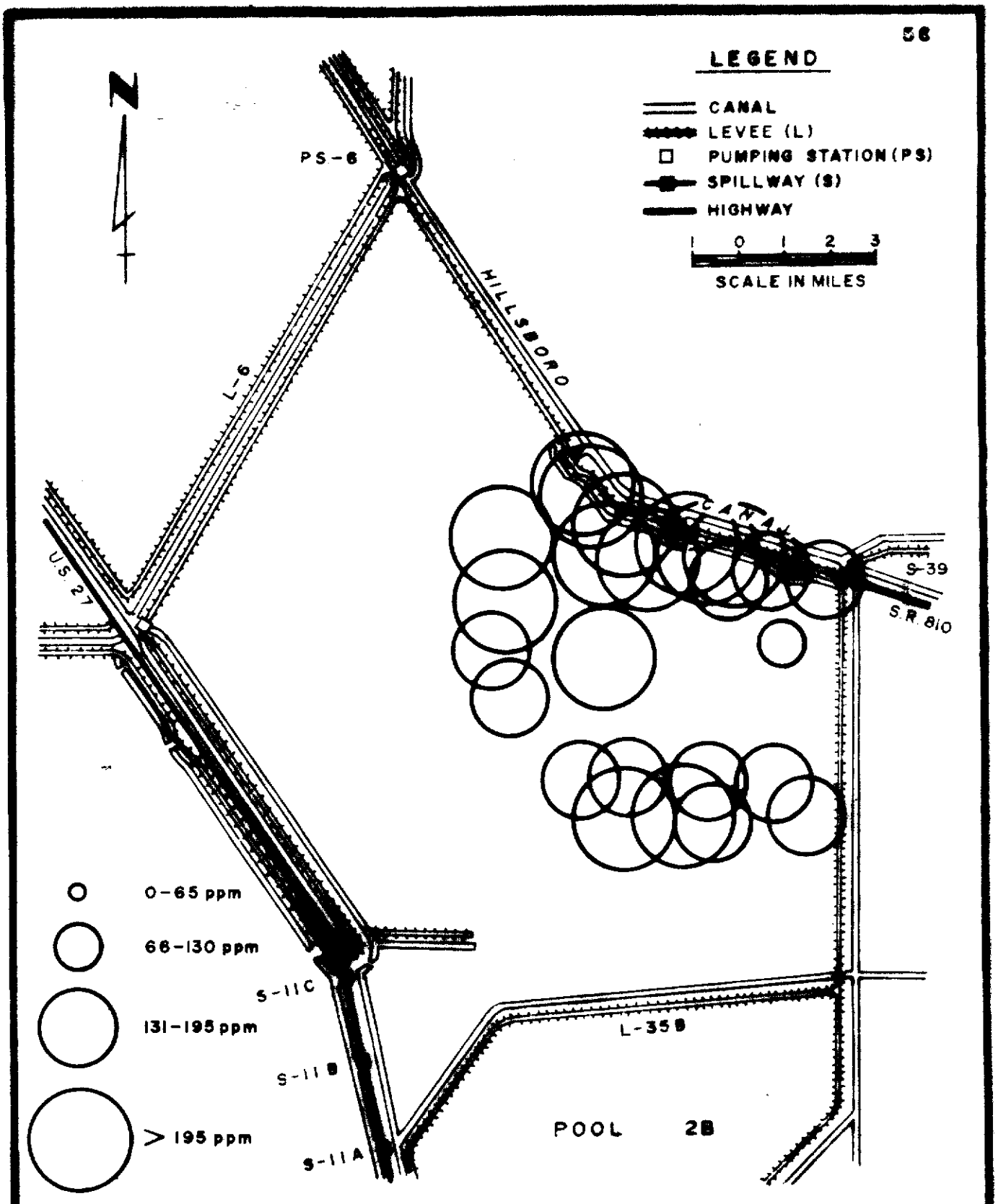
NITRATE CONCENTRATIONS AUGUST 8, 1973

FIGURE 8



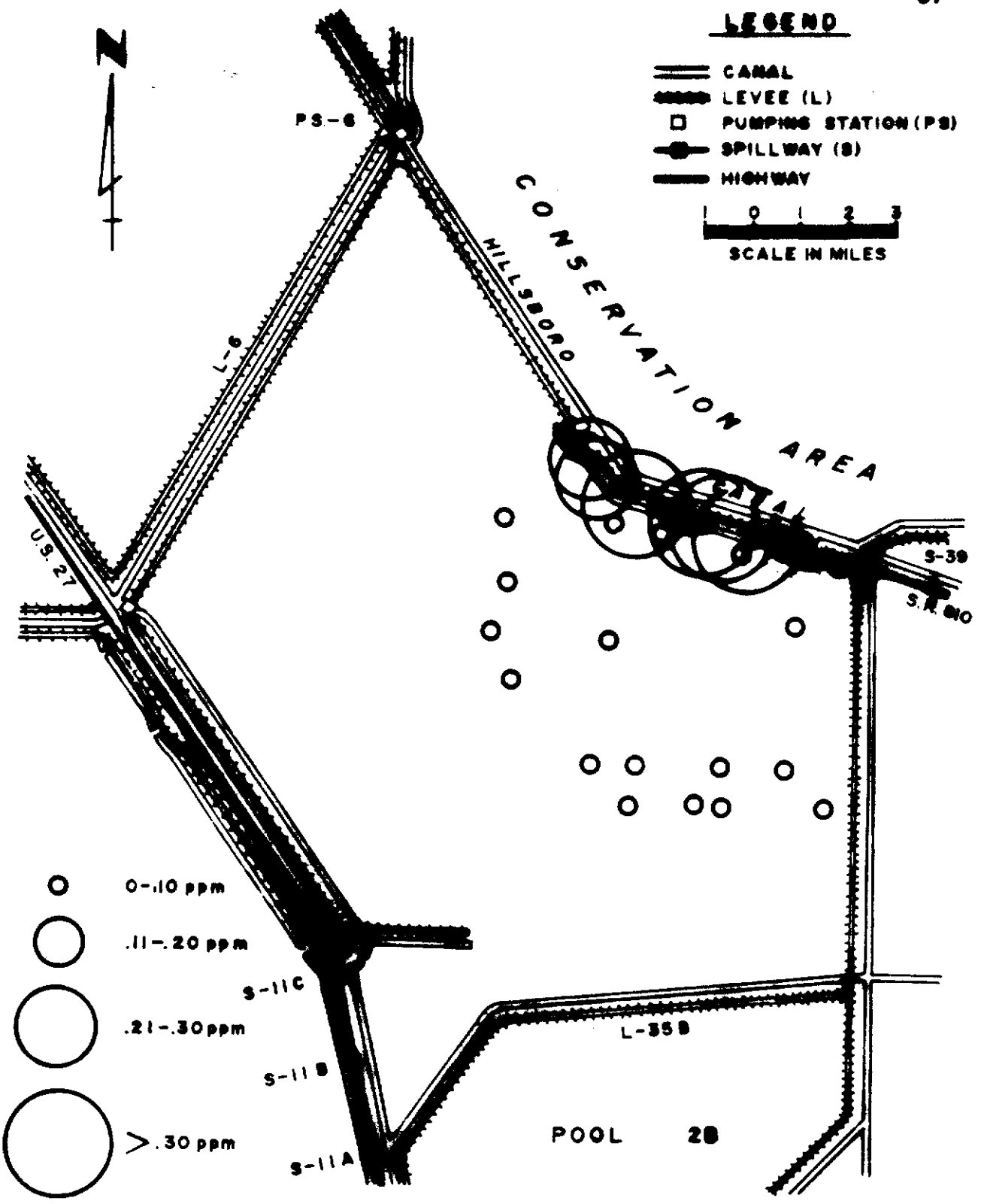
ORTHO PHOSPHATE CONCENTRATIONS
AUGUST 8, 1973

FIGURE 9



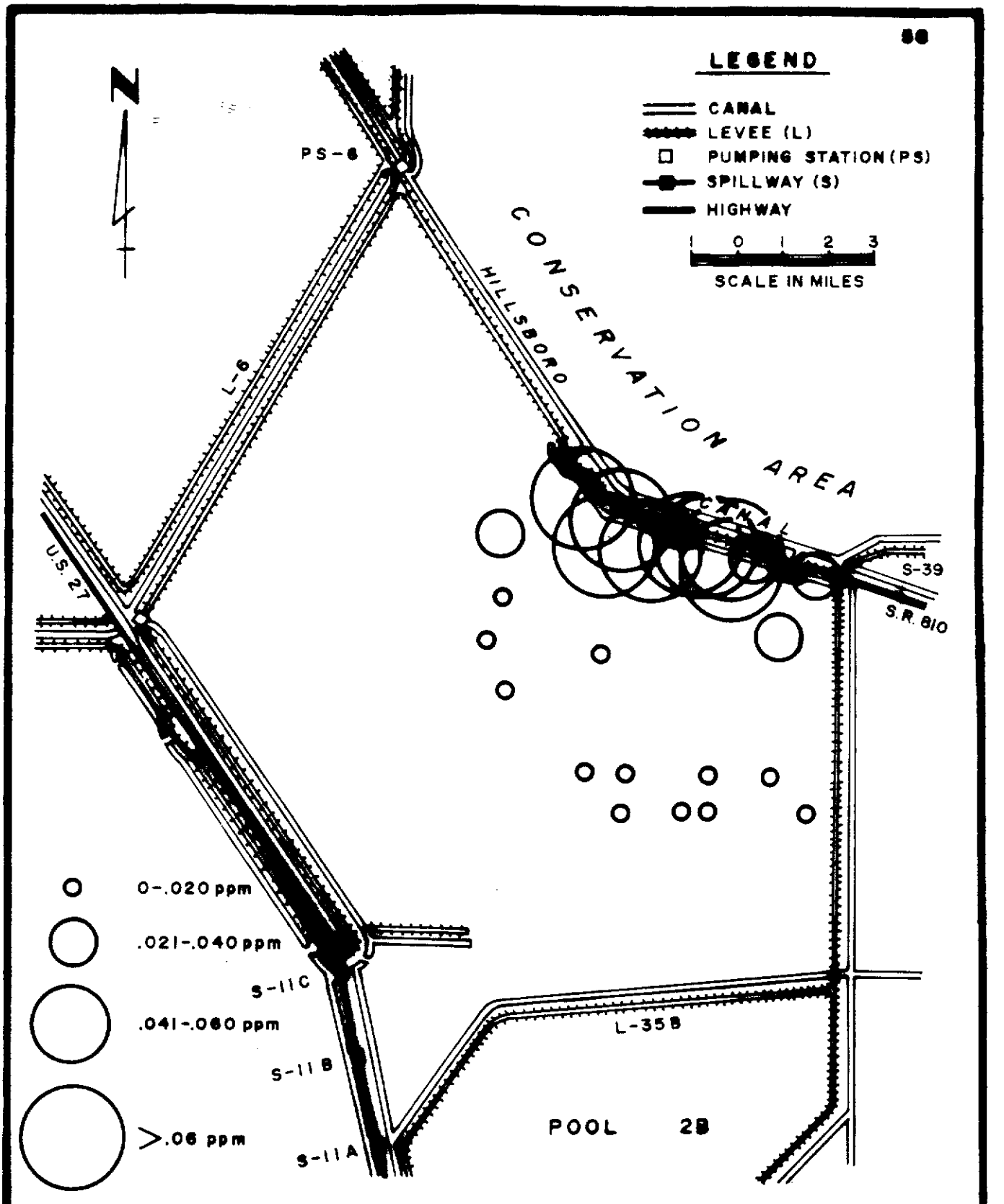
CHLORIDE CONCENTRATIONS
AUGUST 14, 1973

FIGURE 10



NITRATE CONCENTRATIONS
AUGUST 14, 1973

FIGURE 11



ORTHO PHOSPHATE CONCENTRATIONS
AUGUST 14, 1973

FIGURE 12

TABLE 21

ULTIMATE ANALYSIS OF PEAT FROM
CONSERVATION AREA 2A AT VARIOUS DEPTHS

DATA IN PERCENTAGES OF DRY WEIGHT

	Peat (As Received)	Peat (Moisture Free)	Peat (Moisture & Ash Free)
0-6 inches			
Hydrogen	5.6	4.9	5.6
Carbon	44.2	49.5	57.0
Nitrogen	2.9	3.3	3.8
Oxygen	35.0	28.6	32.8
Sulphur	0.7	0.7	0.8
Ash	11.6	13.0	
	100.0	100.0	100.0
26-32 inches			
Hydrogen	5.9	5.4	5.7
Carbon	51.8	57.3	60.8
Nitrogen	2.7	3.0	3.2
Oxygen	34.1	28.1	29.8
Sulphur	0.4	0.5	0.5
Ash	5.1	5.7	
	100.0	100.0	100.0
64-70 inches			
Hydrogen	3.3	2.9	5.7
Carbon	27.7	29.0	56.2
Nitrogen	1.3	1.4	2.7
Oxygen	21.3	18.0	34.9
Sulphur	0.3	0.3	0.5
Ash	46.1	48.4	
	100.0	100.0	100.0

Sampling Date	Linear Regression Equation	Correlation Coefficient (r)
July 31, 1973	y = .808x -5.56	.99
August 8, 1973	y = .773x +5.34	.93
August 14, 1973	y = .868x -17.7	.99
August 22, 1973	y = .764x - 12.1	.92

These data strongly suggest that chloride and sodium are unaffected by vegetation in the marsh, a relationship suggested by Gleason (1972) in his work on Taylor Slough, Everglades National Park. Oddly enough, water entering CA-2A at S-7 does not exhibit a significant linear relationship between Na and Cl.

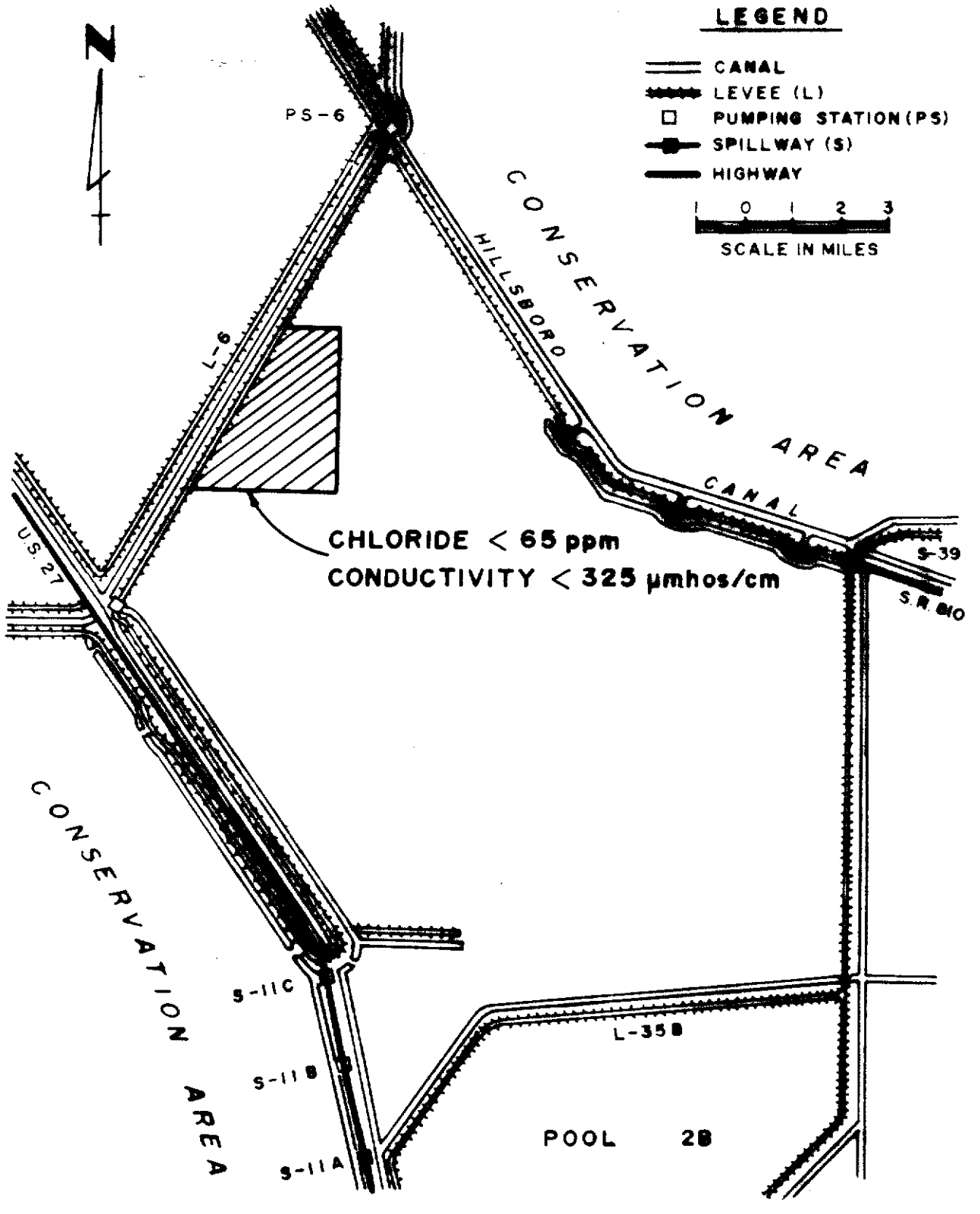
The average of mean silica concentrations for canal and marsh waters are identical - 19 ppm (Table 9). These data suggest that high silica concentrations in the marsh are stable. Abundant siliceous vegetation and diatoms in the marsh are apparently not able to lower the SiO_2 concentration. Silica in most bodies of water is kept low by uptake through diatoms. Seawater contains not more than 6 ppm SiO_2. The periphyton in CA-2A contains diatoms but increases in the diatom population allowable by high silica may be prohibited by "nutrient limitations". The diatoms may be unable to keep up with the high SiO_2 inputs because of a shortage of nitrogen or phosphorus compounds.

Silica entering the area has two likely sources: (1) decomposition of silica-rich peat (2) groundwater. Silica in peatlands drained by the Hillsboro and New River Canals contains approximately 2.2% SiO_2 by dry weight (Miller, 1918). Organically-deposited opaline silica is usually very soluble though sawgrass silica is not amorphous. Closely

associated organic matter is known to enhance the solubility of even highly insoluble quartz silica. The silica content of ground water in Broward County is high (Grantham and Sherwood, 1968). Toward the agricultural lands ground water is even more highly mineralized (Parker, et al., 1955).

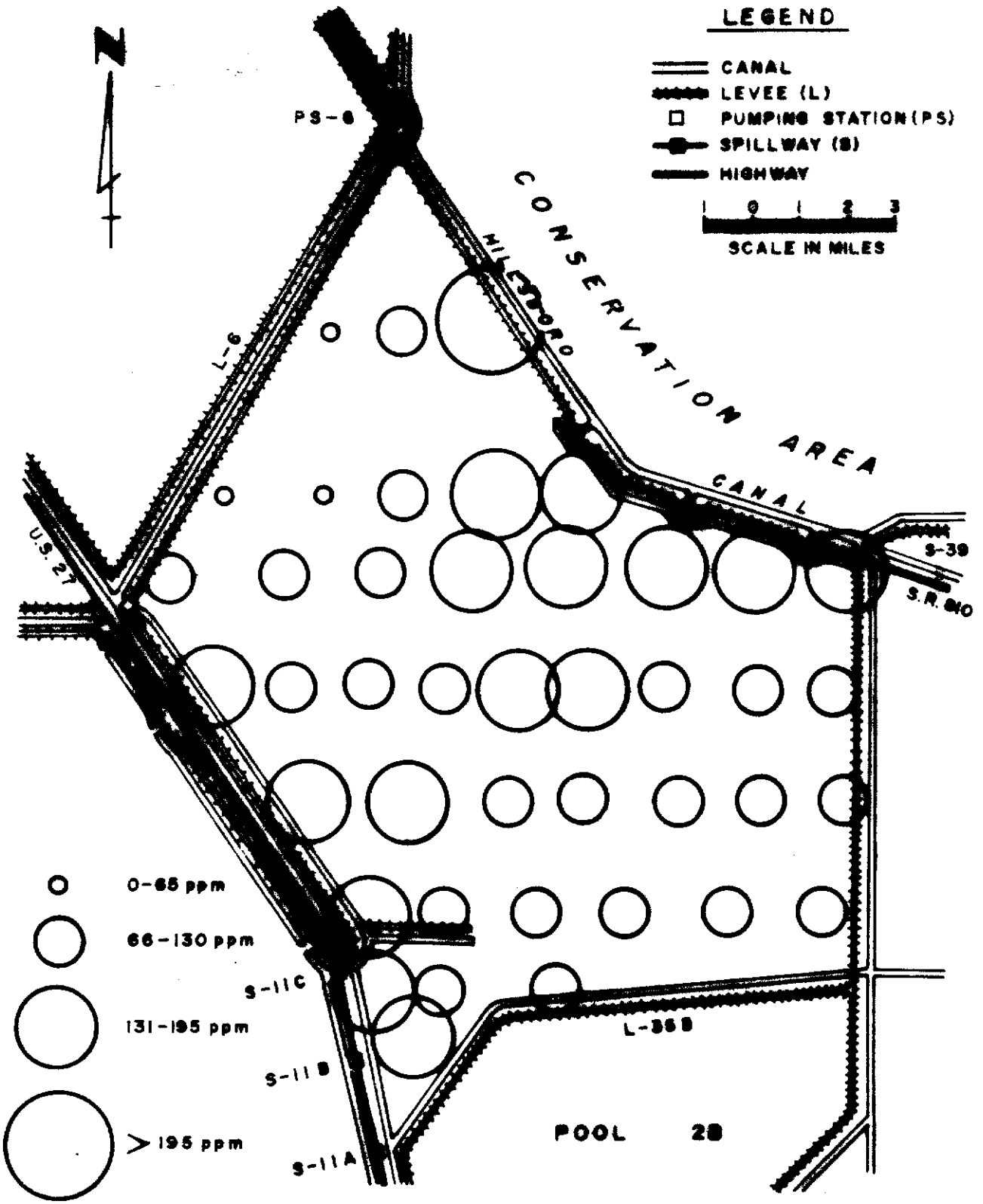
Some support for the hypothesis that periphyton are precipitating $CaCO_3$, thereby reducing the alkalinity and conductivity of the marsh water, is found in Table 9. Though chloride, sodium and SiO_2 in both the marsh and canal are very similar, the alkalinity difference represents a bicarbonate difference of 103 ppm. Bicarbonate would naturally undergo a reduction with $CaCO_3$ precipitation. Examination of abundant Microcoleus lyngbyaceous, a blue-green alga abundant around the S-10 structures during August, indicated that $CaCO_3$ crystals were forming between and around the algal filaments. However, the vegetation in the marsh may reduce the alkalinity and conductivity of the water by simply absorbing carbon dioxide or bicarbonate from the water during photosynthesis.

A small northwest section was unaffected by high-conductivity and high-chloride water prevalent over the rest of CA-2A (Figure 13). This can be seen by examining Figures 14 - 17 which show that low concentrations of ions in this area were stable during both wet and dry seasons. The isolated area is uphill and more than three miles distance from both S-7 and S-10D; it is also far enough away from CA-1 to be unaffected by high-conductivity seepage water. Possibly this area which has chloride values less than 65 ppm has been affected only by rainwater in its past history. Chloride values for Taylor Slough, a small slough in Everglades National Park, which in the past received only water from rainfall, ranged from 15 ppm - 40 ppm throughout the length of the slough, July 27,



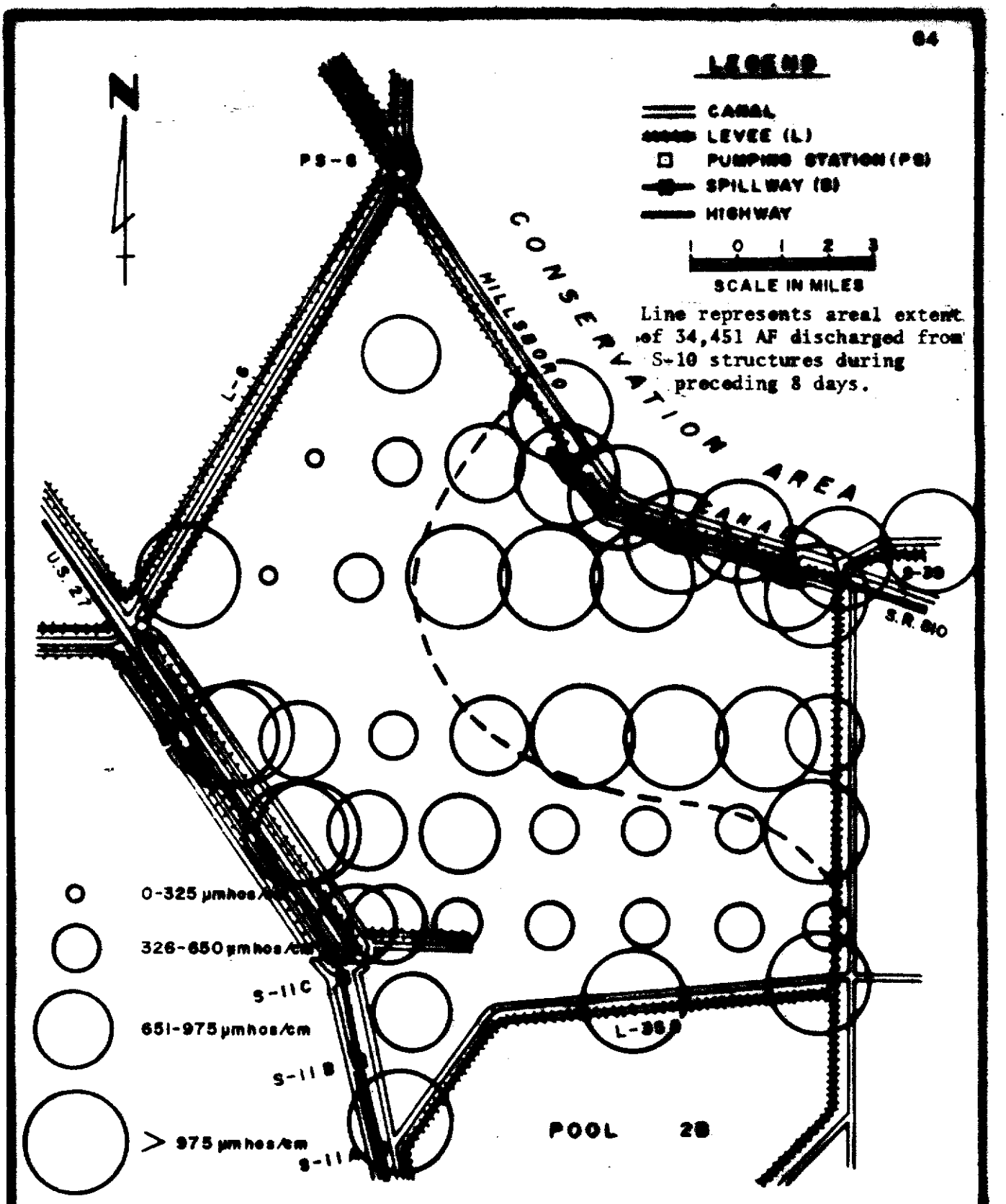
AREA UNAFFECTED BY HIGH-CONDUCTIVITY AND HIGH CHLORIDE WATER

FIGURE 13



CHLORIDE CONCENTRATIONS
OCTOBER 11, 1972

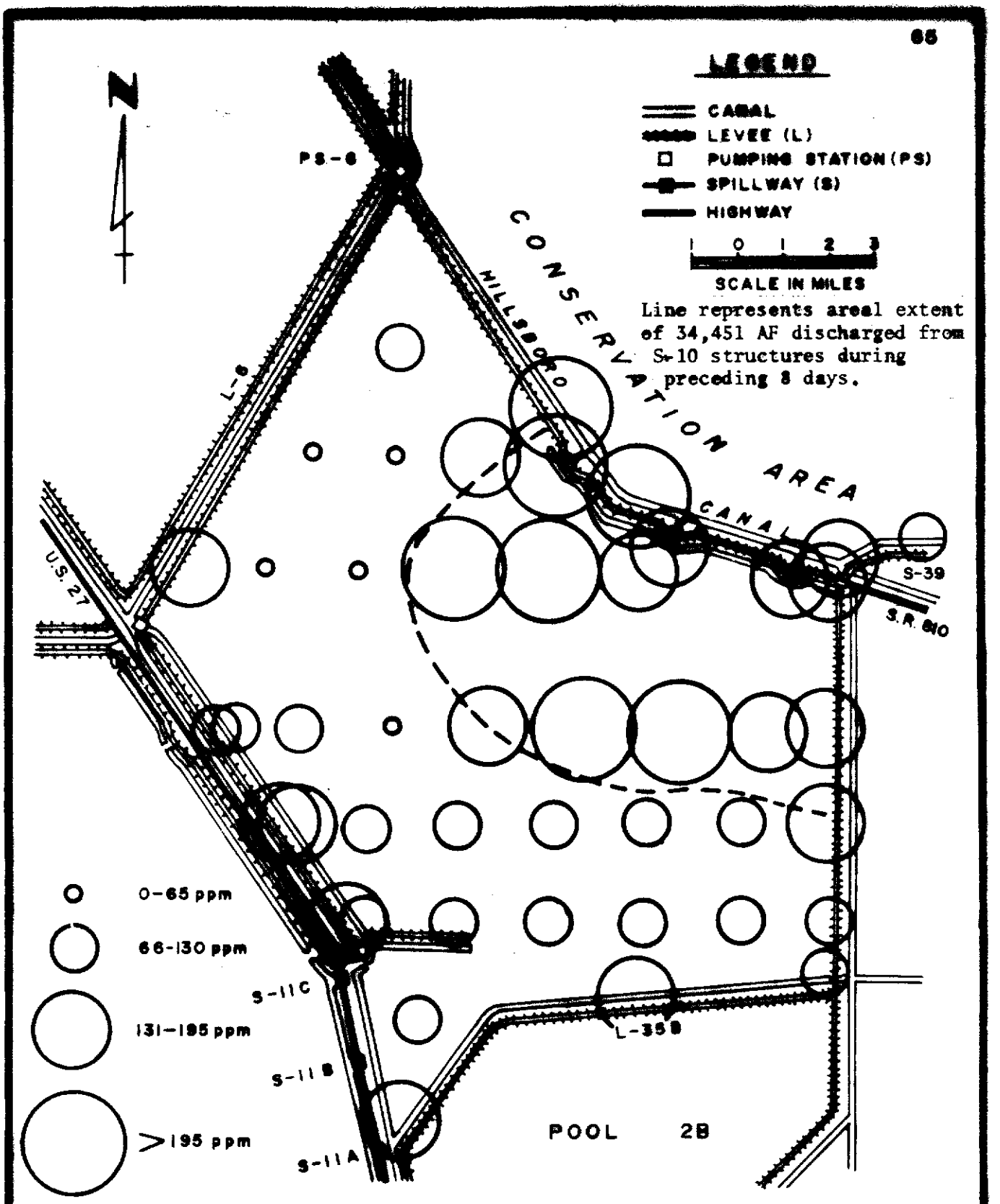
FIGURE 14



CONDUCTIVITY

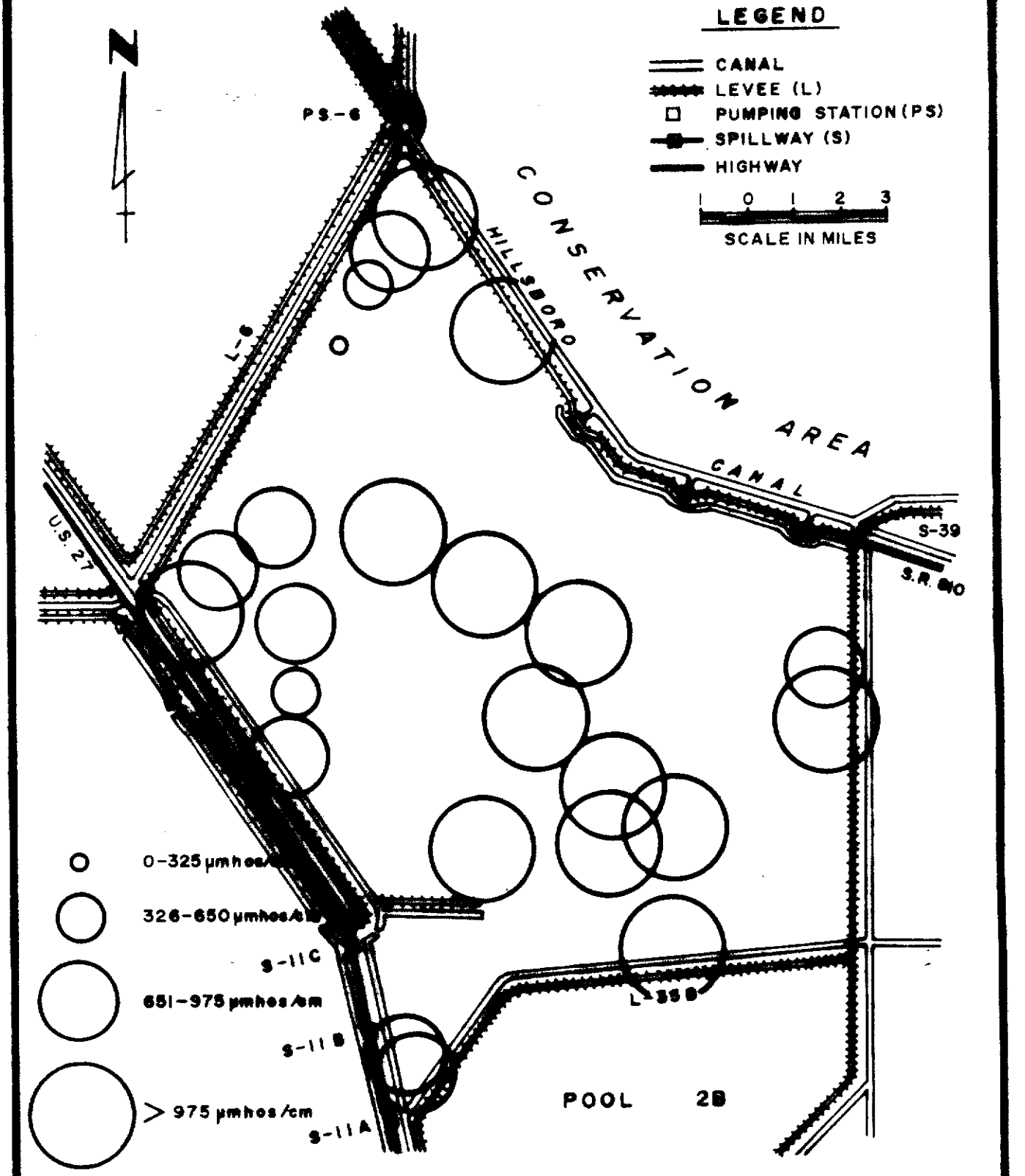
JULY 31, 1973

FIGURE 15



CHLORIDE CONCENTRATIONS
JULY 31, 1973

FIGURE 16



CONDUCTIVITY
SEPTEMBER 17, 1973

FIGURE 17

1971 (Gleason, 1972).

The boundary between canal water flowing into the marsh and indigeneous water was clearly marked by a contrast between water containing high and low dissolved solids on July 31, eight days after the S-10 structures were opened (Figures 15 and 16). The 112 gauge is the only gauge which had responded to the discharge at that time; the 2-17 and 2-15 gauges had not sensed the rising water level. The rate of expansion of the bubble was approximately one mile per day from S-10C towards the S-11 structure.

By September, the area below the latitude of the S-10 gates was fairly homogeneously high in dissolved solids. The boundary between the water input by S-7 and the water emanating from S-10 was not clear. The thick sawgrass southeast of S-7 apparently resisted some movement of the high salinity water through it; a small patch of respectably "soft" water was found (Figure 17).

Water emanating from S-7 possessed a significantly higher alkalinity than water issuing from the S-10 structures. The difference corresponds to about 120 ppm bicarboante using the conversion factor of 61 ppm HCO_3/meq-Alk.

Our July and August canal data confirm Parker, et al.'s contention that high dissolved solids occur in some Everglades canals concurrently with the wet season and high discharge conditions. Our specific conductance values for the North New River and Hillsboro Canals are at the high side of historical ranges. The reason for this unreasonable relationship is not clear. Several factors may be involved: 1) flushing of high conductance groundwater into the canals during active drainage of the ag-lands 2) active dissolution of the underlying bedrock as water

is drained out of bedrock, which is overlain by peats, within the ag-lands. More long term data is needed to clarify the relationship.

SUMMARY

The chemical quality of Conservation Area 2A and adjacent supply canals was good with two exceptions: 1) Specific Conductance of marsh and canal water exceeded water quality standards 2) Ammonia in canals frequently exceeded standards. A comparison of our two months of wet-season canal data with previous work suggested that the Hillsboro and North New River Canals have not changed their chemical complexion since the 1940's. A comparison of water analyses, then and now, showed that the water has always been hard and has contained bicarbonate, chloride, sodium, silica, and nitrate in the same order of abundance.

Our canal data were towards the higher range of historical data. Nitrate was 5-10X concentrations found in previous studies. Nitrate rather than ammonia was the most abundant form of inorganic nitrogen. Sampling canals only when they were actively draining adjacent ag-lands may possibly explain these differences.

The Everglades marsh had a purifying or "kidney" effect on agricultural drainage discharged over the marsh. Nutrients decreased to levels below detection limits in the marsh and alkalinity also showed a slight reduction perhaps due to $CaCO_3$ precipitation. The marsh exhibited no effect on chloride, sodium, or silica. Dissolved organic nitrogen and organic phosphate phosphorus concentrations did not change as a result of flow through the marsh. This result suggests that they were not usable as nutrient substrates for organisms over the time period encompassed by treatment in the study (1 month).

The drawdown of CA-2A, dehydration of flocculent "gyttja," and oxidation of surface soils did not have an obvious determinable effect, either beneficial or deleterious, on the chemical quality of water refilling the basin. Water refilling the basin appeared to derive its personality primarily from Hillsboro Canal water less any significant concentrations of nutrients.

Sodium and chloride concentrations of water entering the marsh through the S-10 structures and in the marsh exhibited a strong direct linear relationship.

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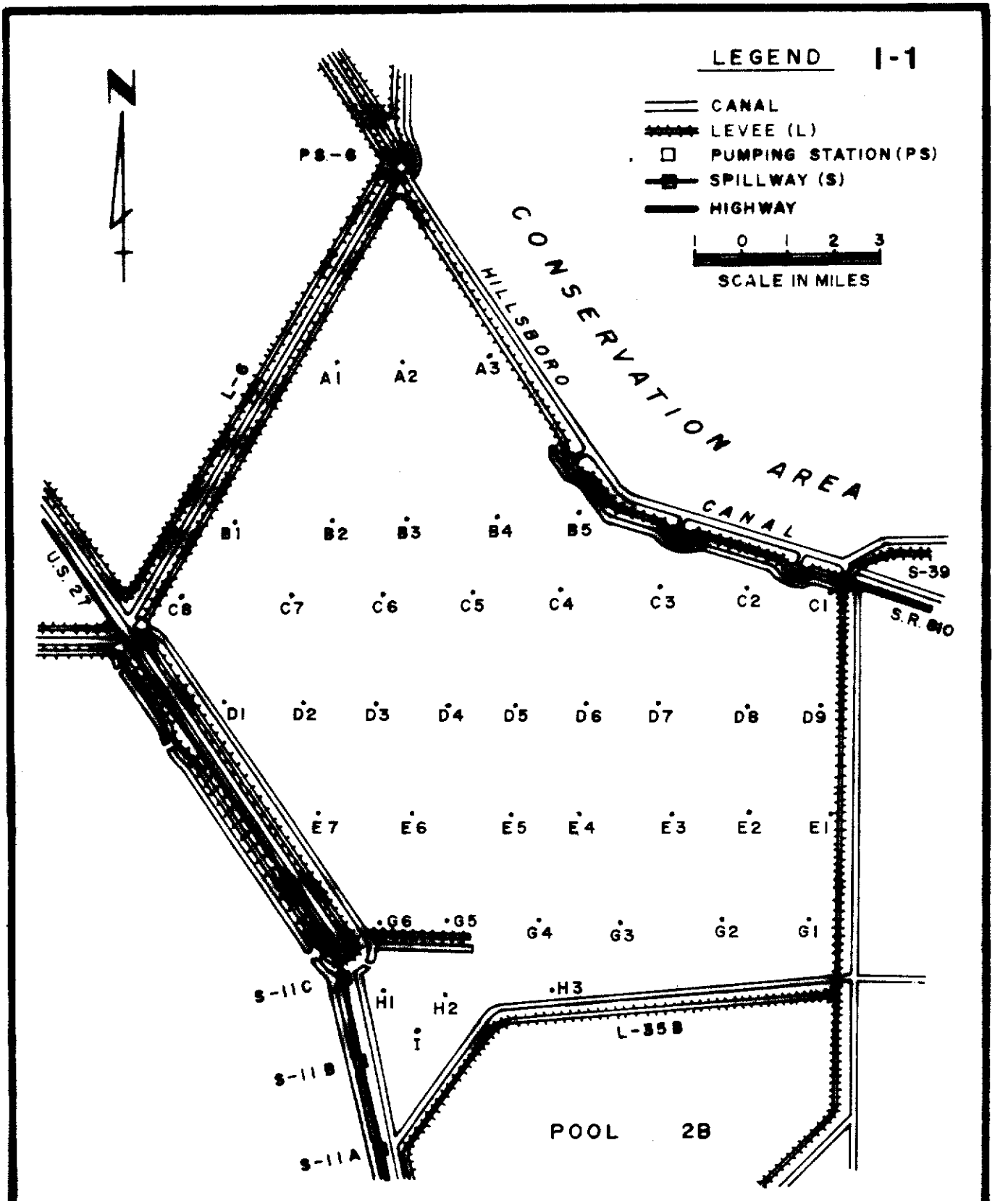
APPENDIX I

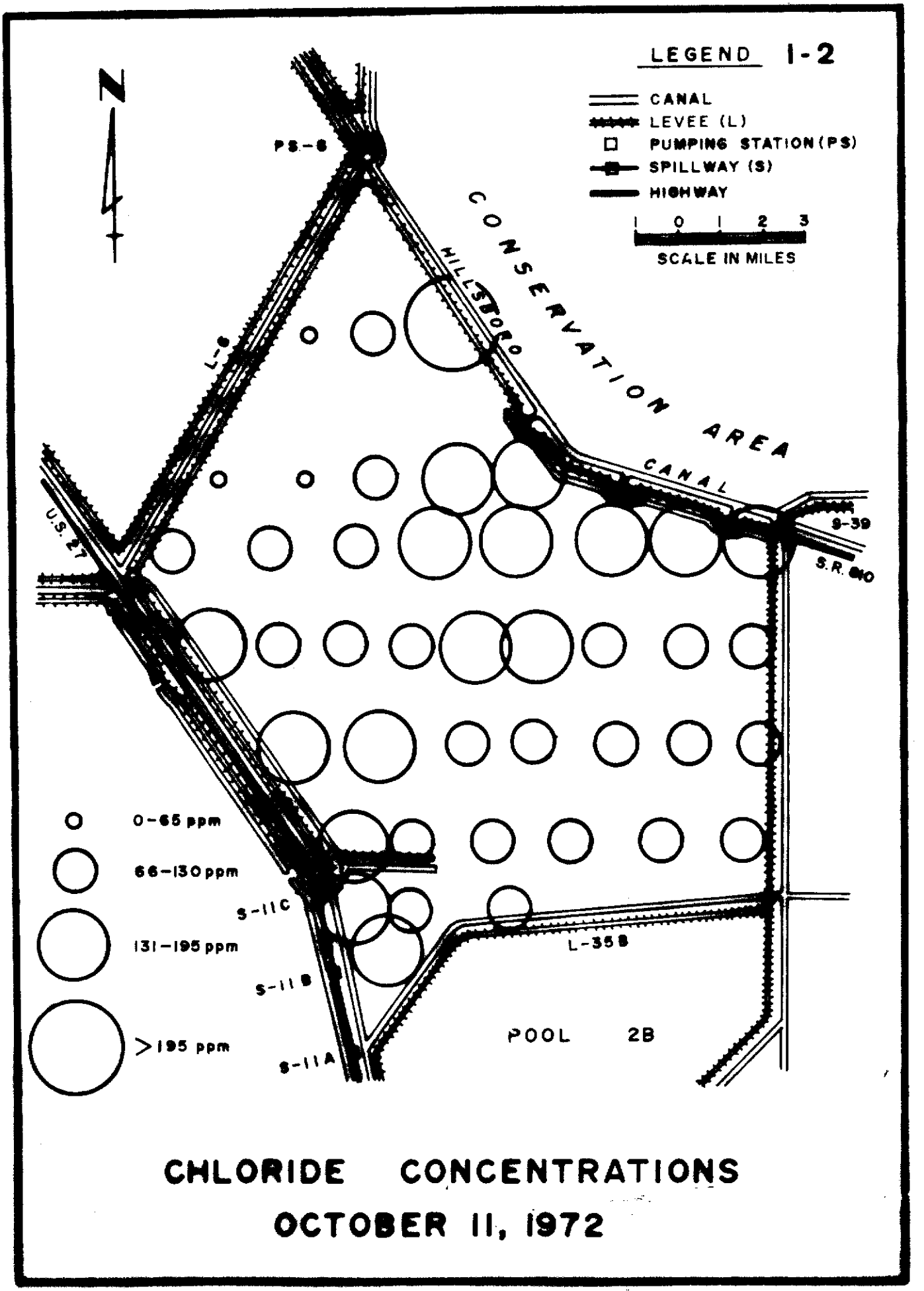
SAMPLING AND CHEMICAL COMPOSITION MAPS FOR

CA-2A

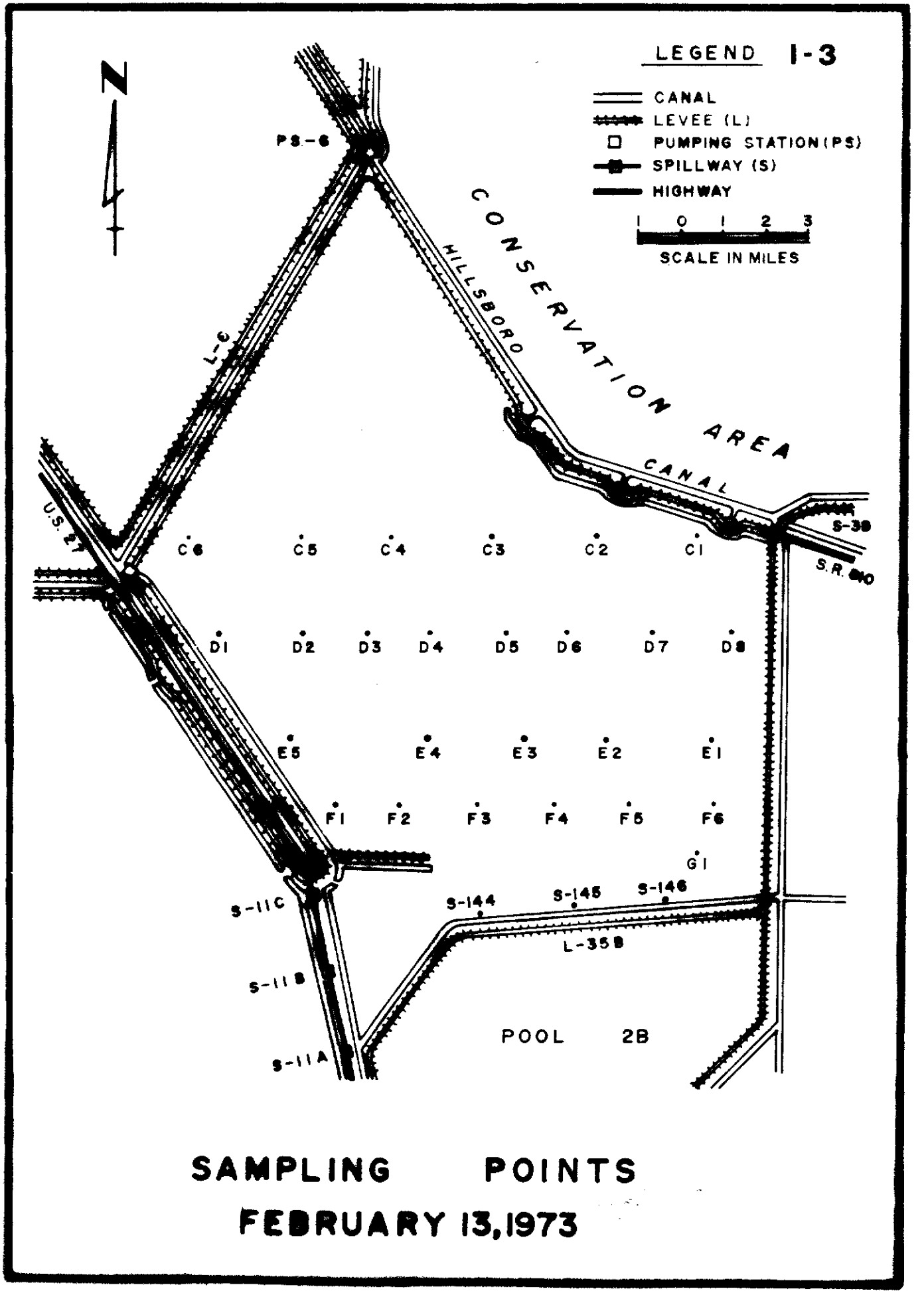
OCTOBER 11, 1972 - AUGUST 22, 1973



SAMPLING POINTS
OCTOBER 11, 1972

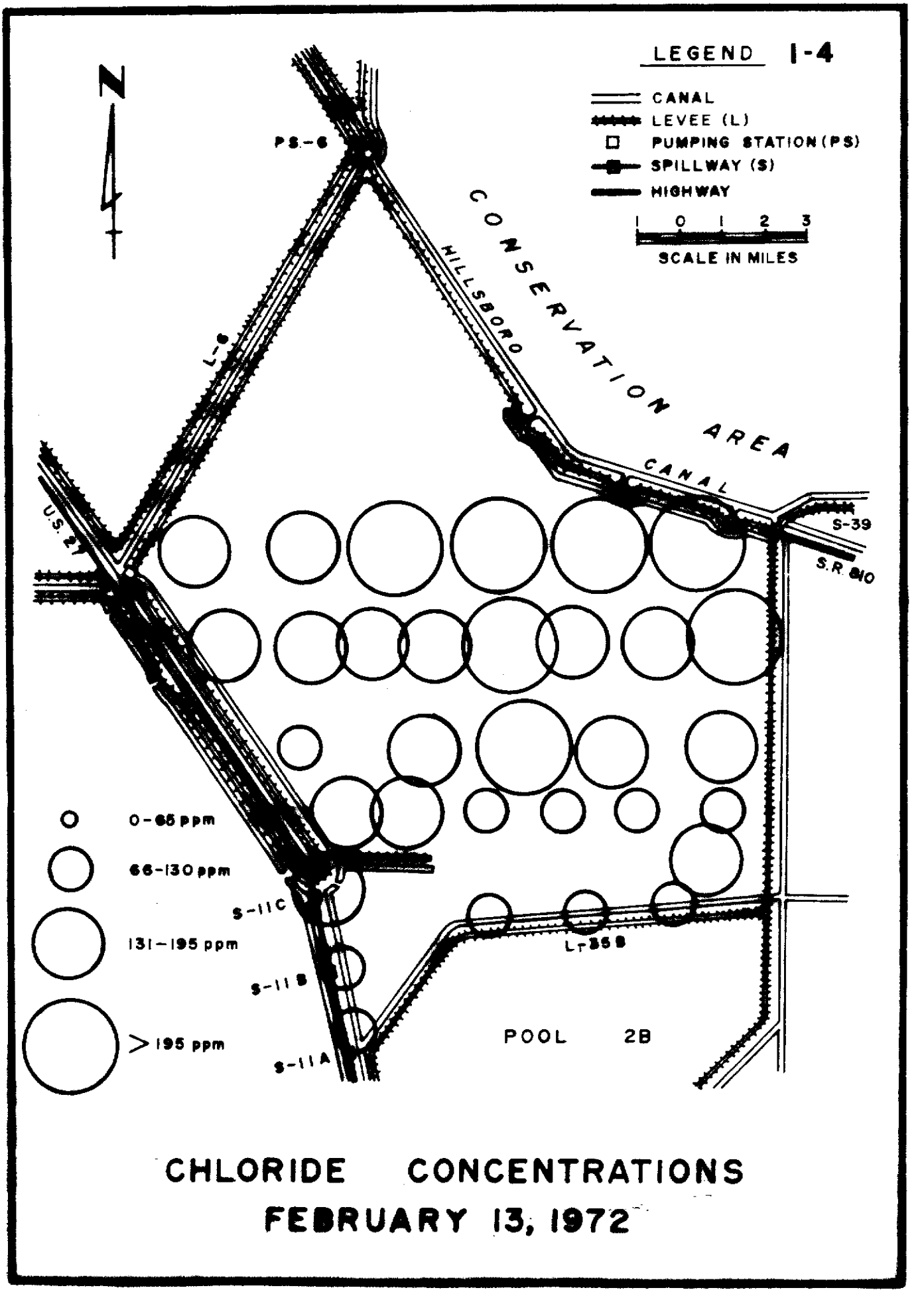


CHLORIDE CONCENTRATIONS
OCTOBER 11, 1972



SAMPLING POINTS

FEBRUARY 13, 1973



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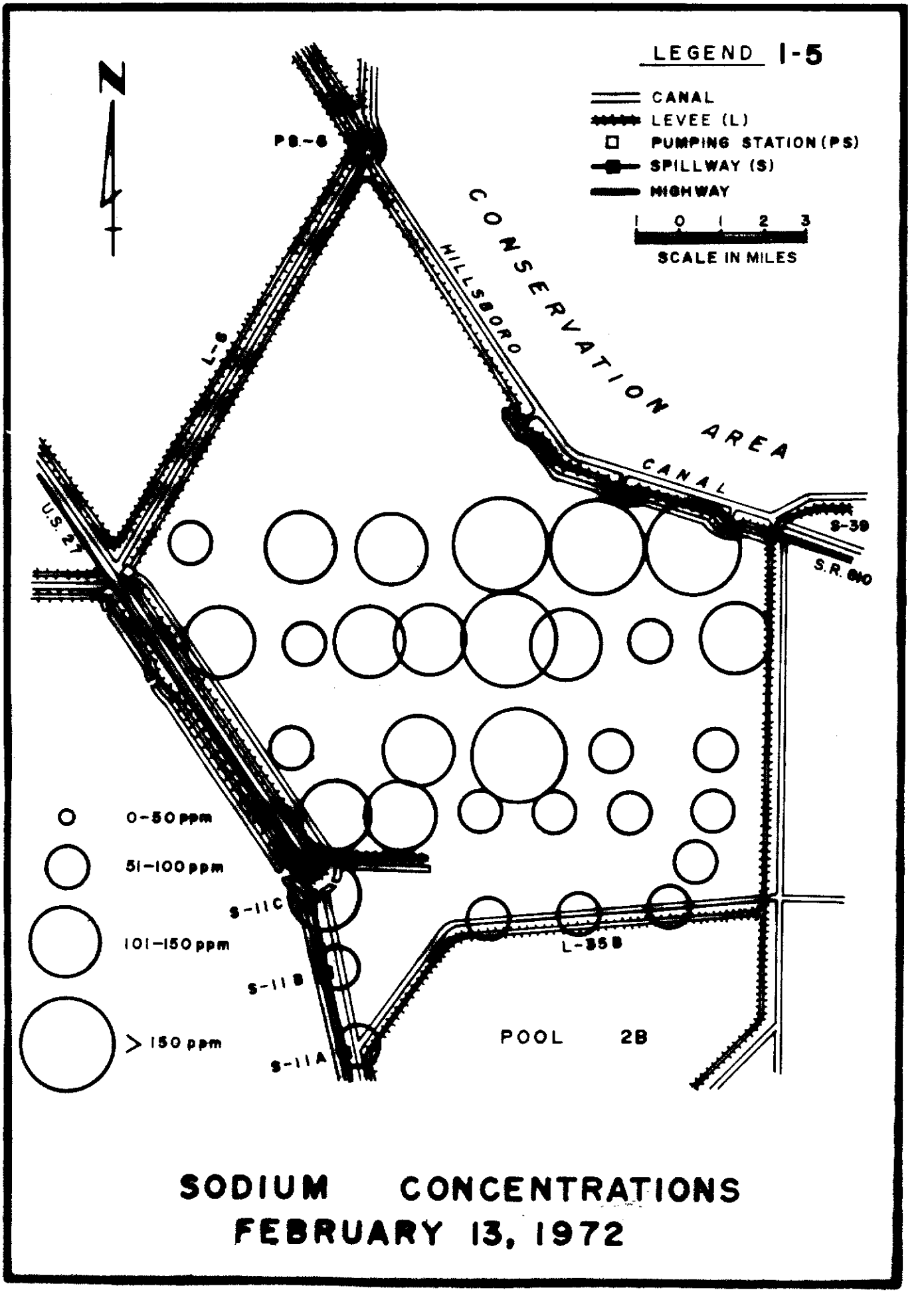
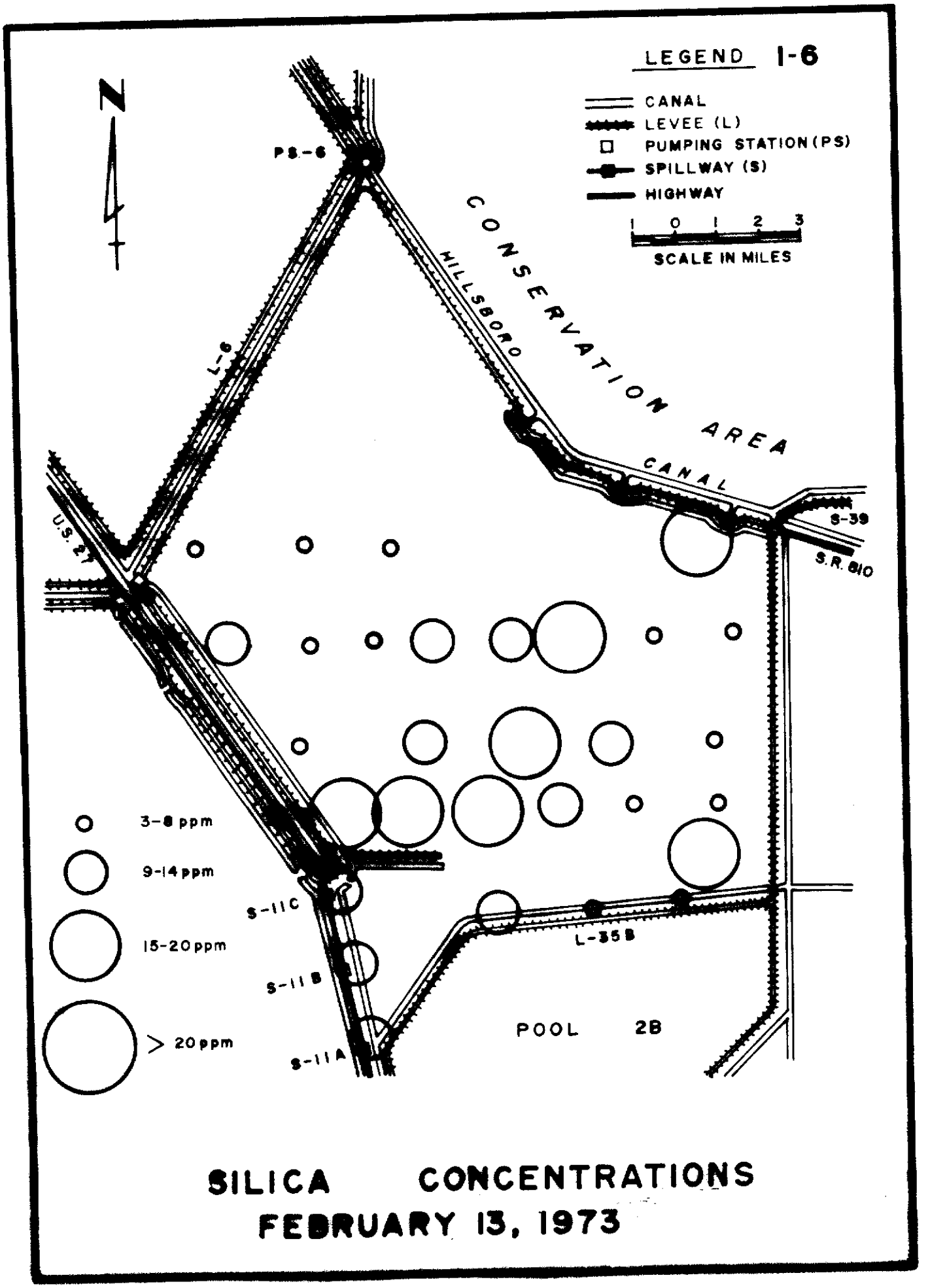


SODIUM CONCENTRATIONS
FEBRUARY 13, 1972



SILICA CONCENTRATIONS
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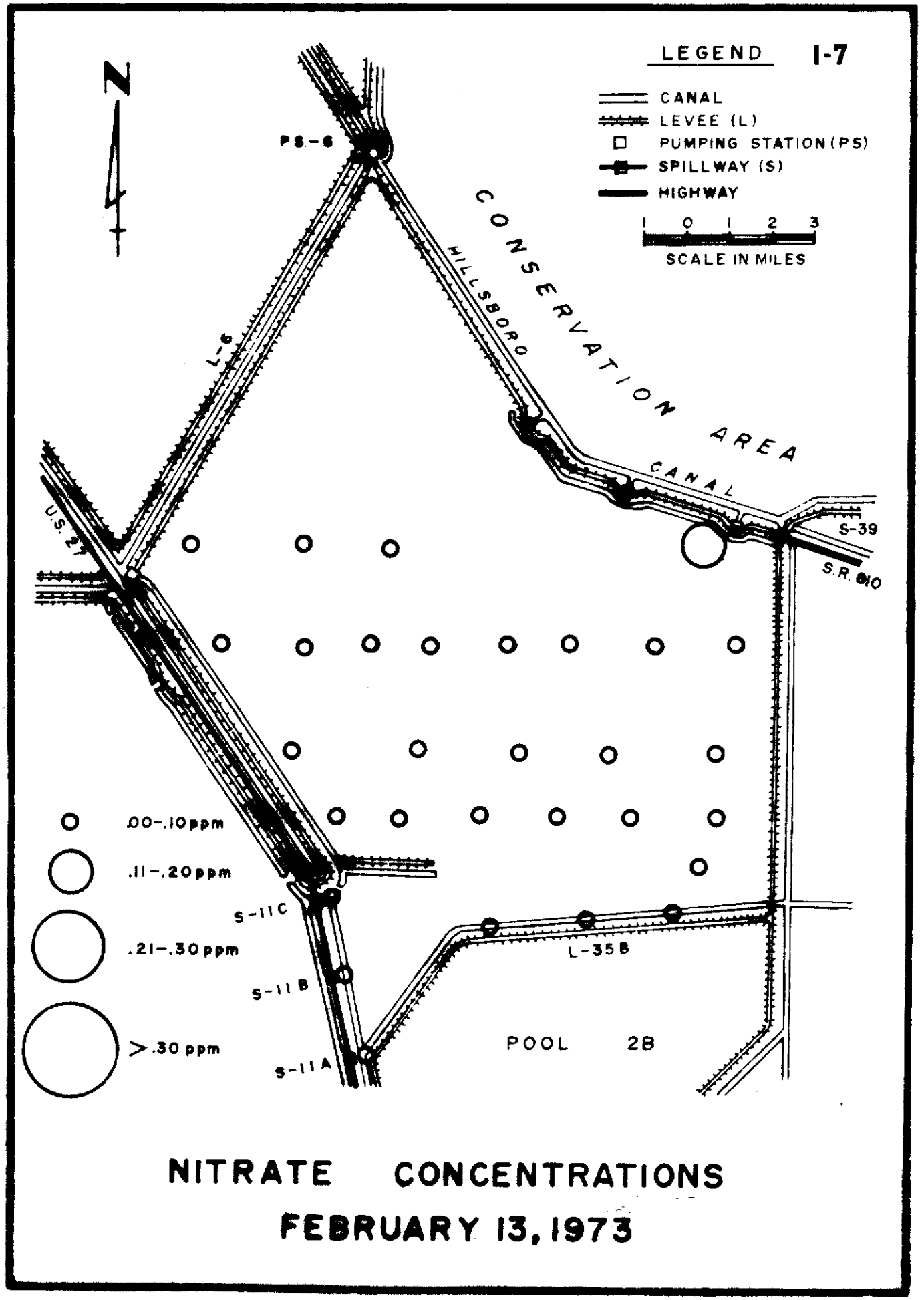
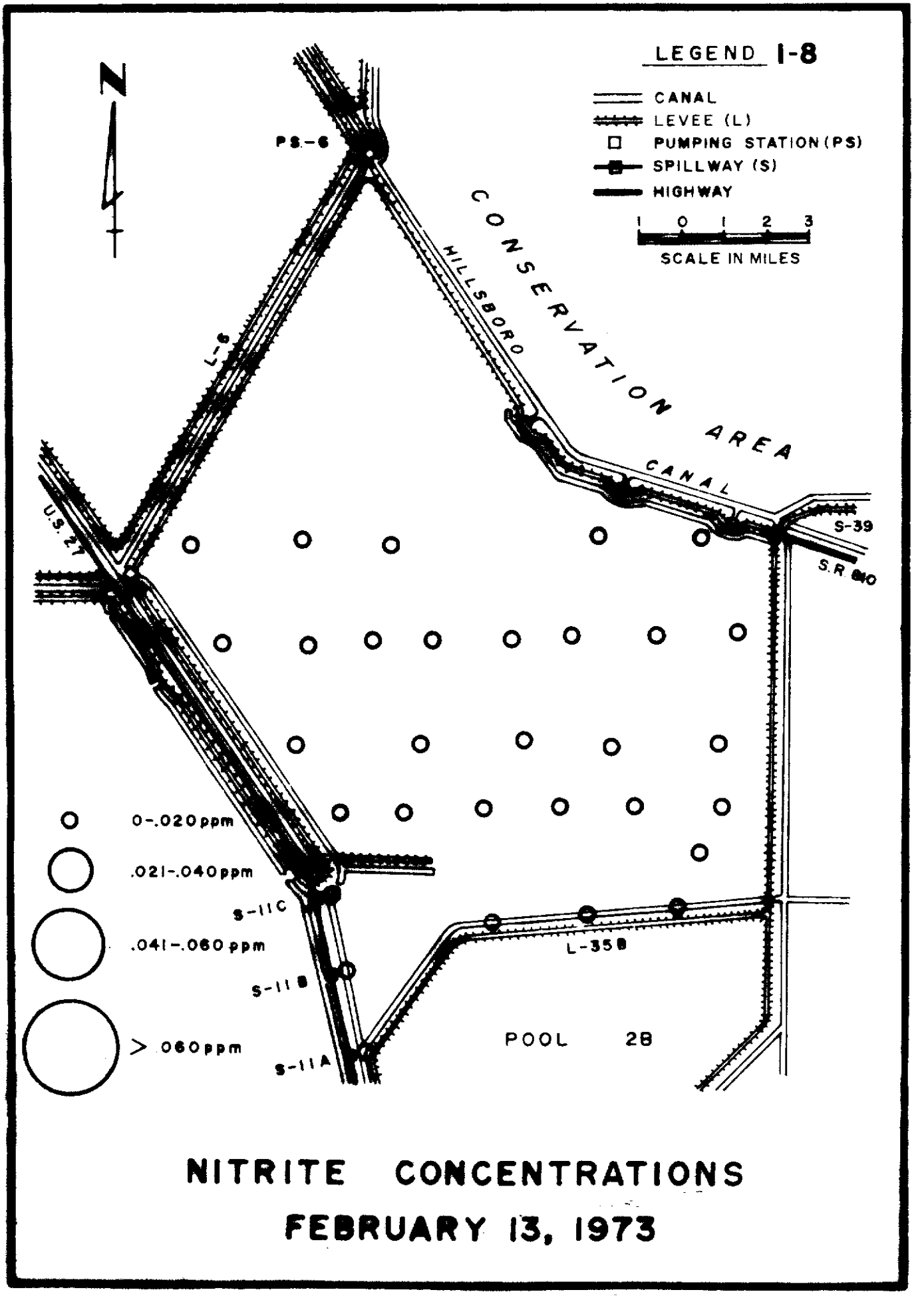


NITRATE CONCENTRATIONS
FEBRUARY 13, 1973



NITRITE CONCENTRATIONS

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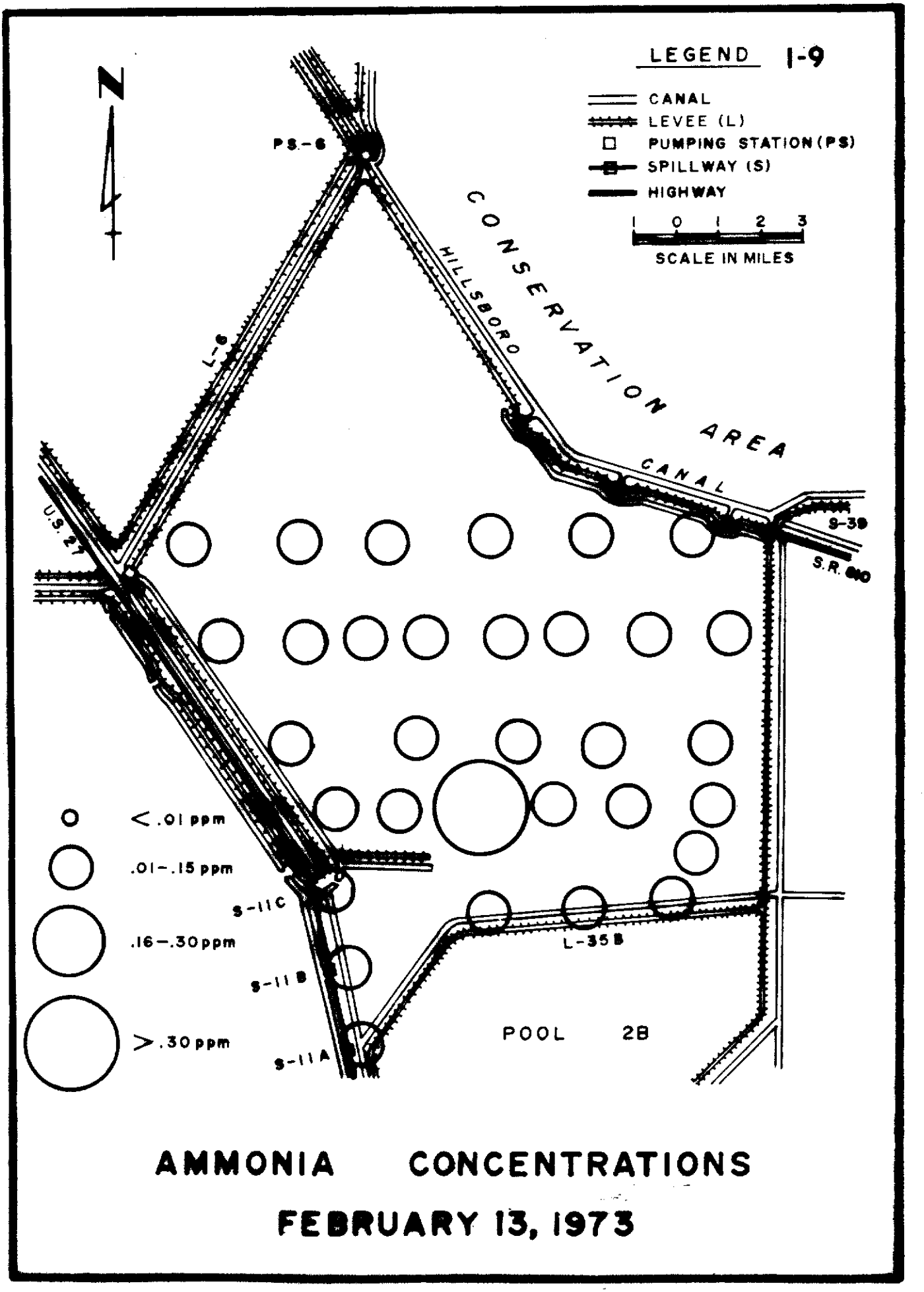

AMMONIA CONCENTRATIONS

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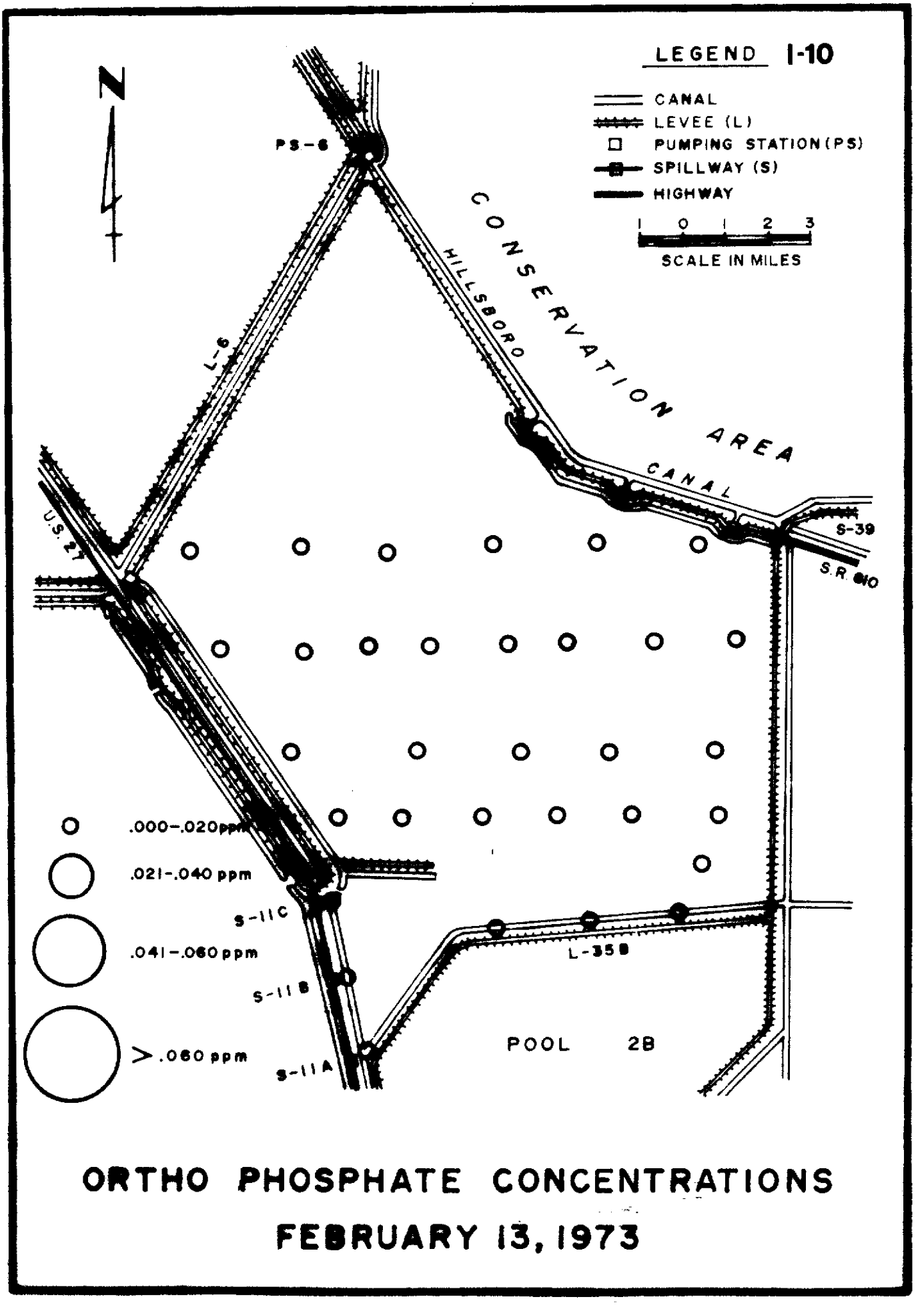
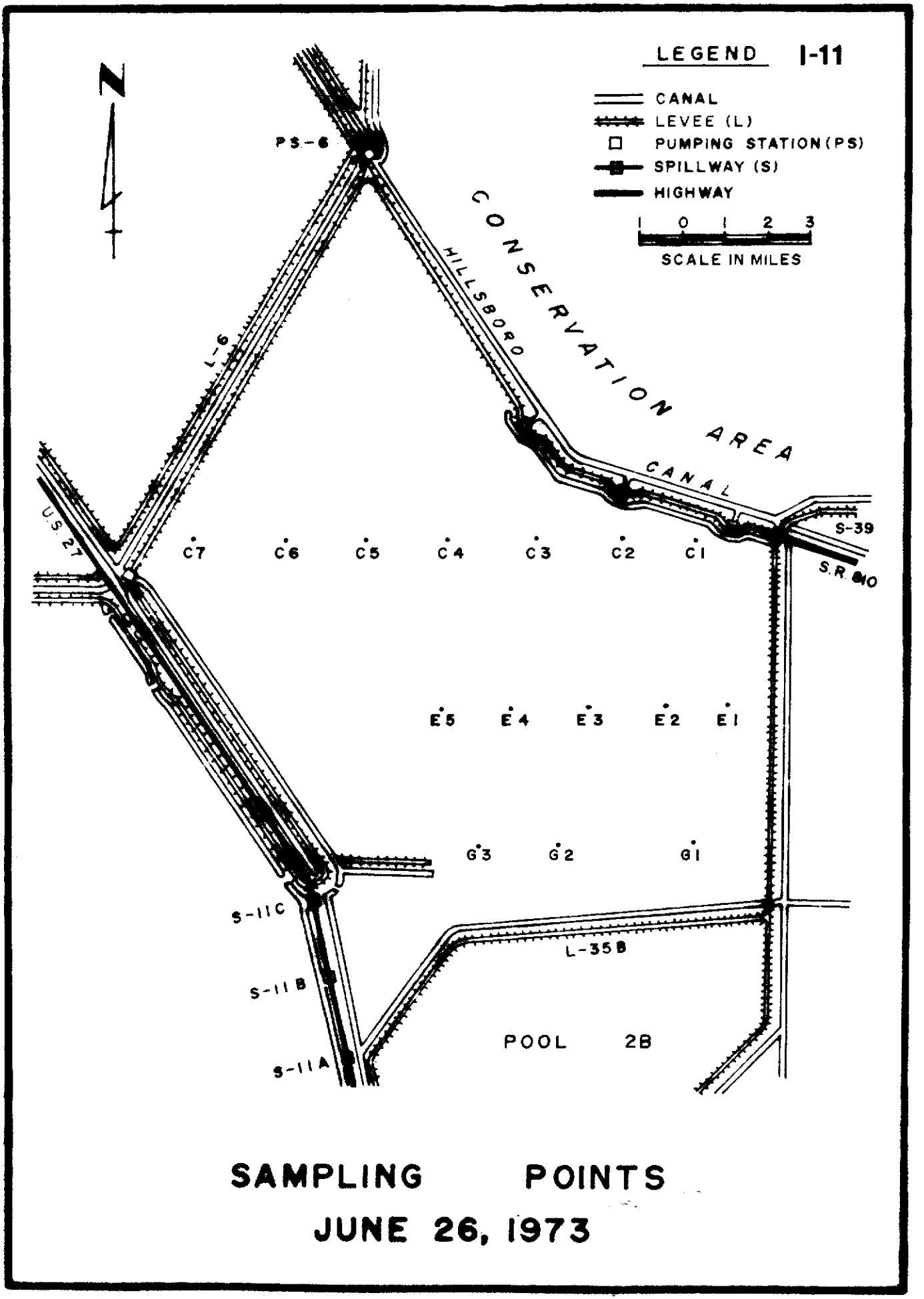


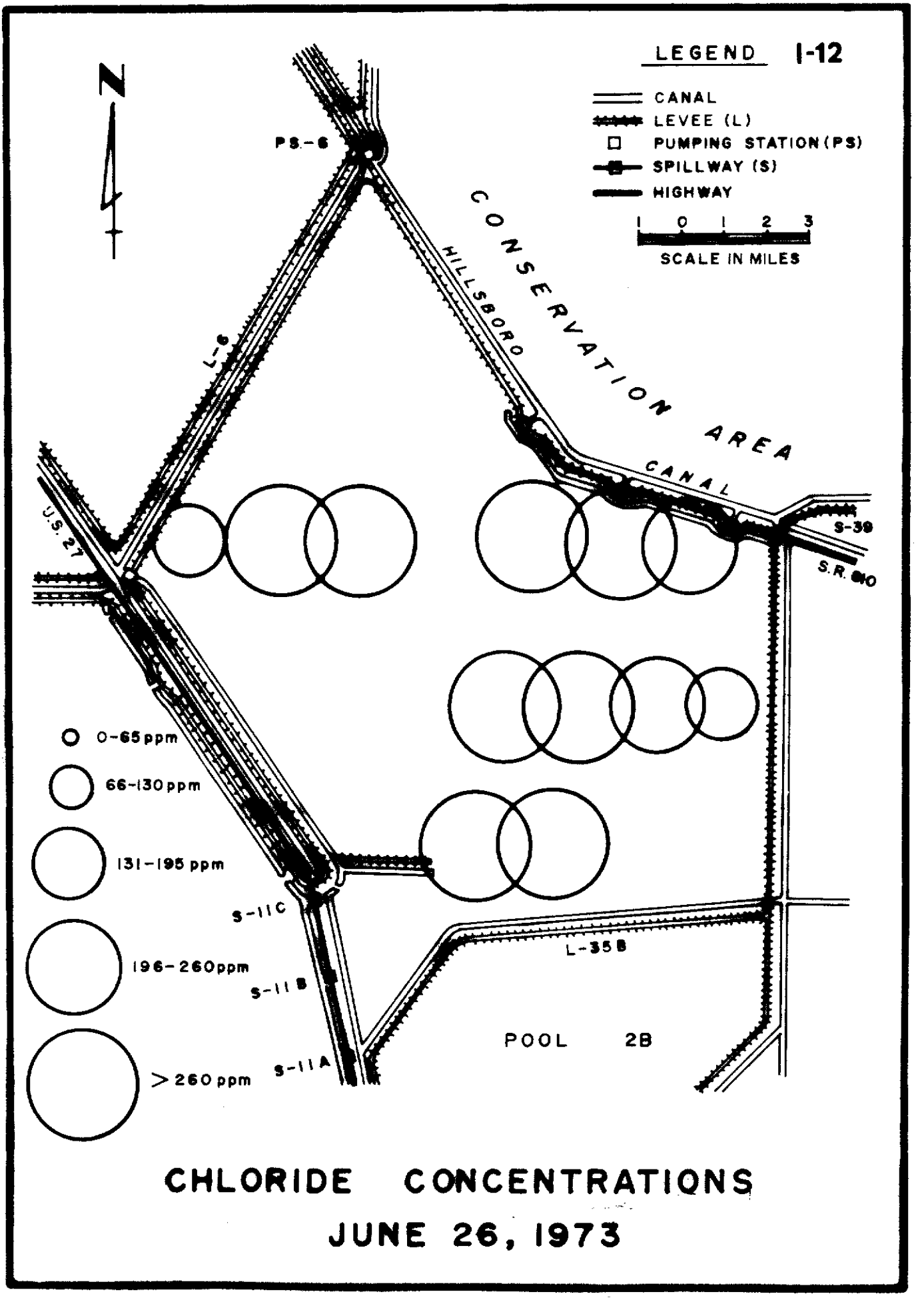
ORTHO PHOSPHATE CONCENTRATIONS

FEBRUARY 13, 1973



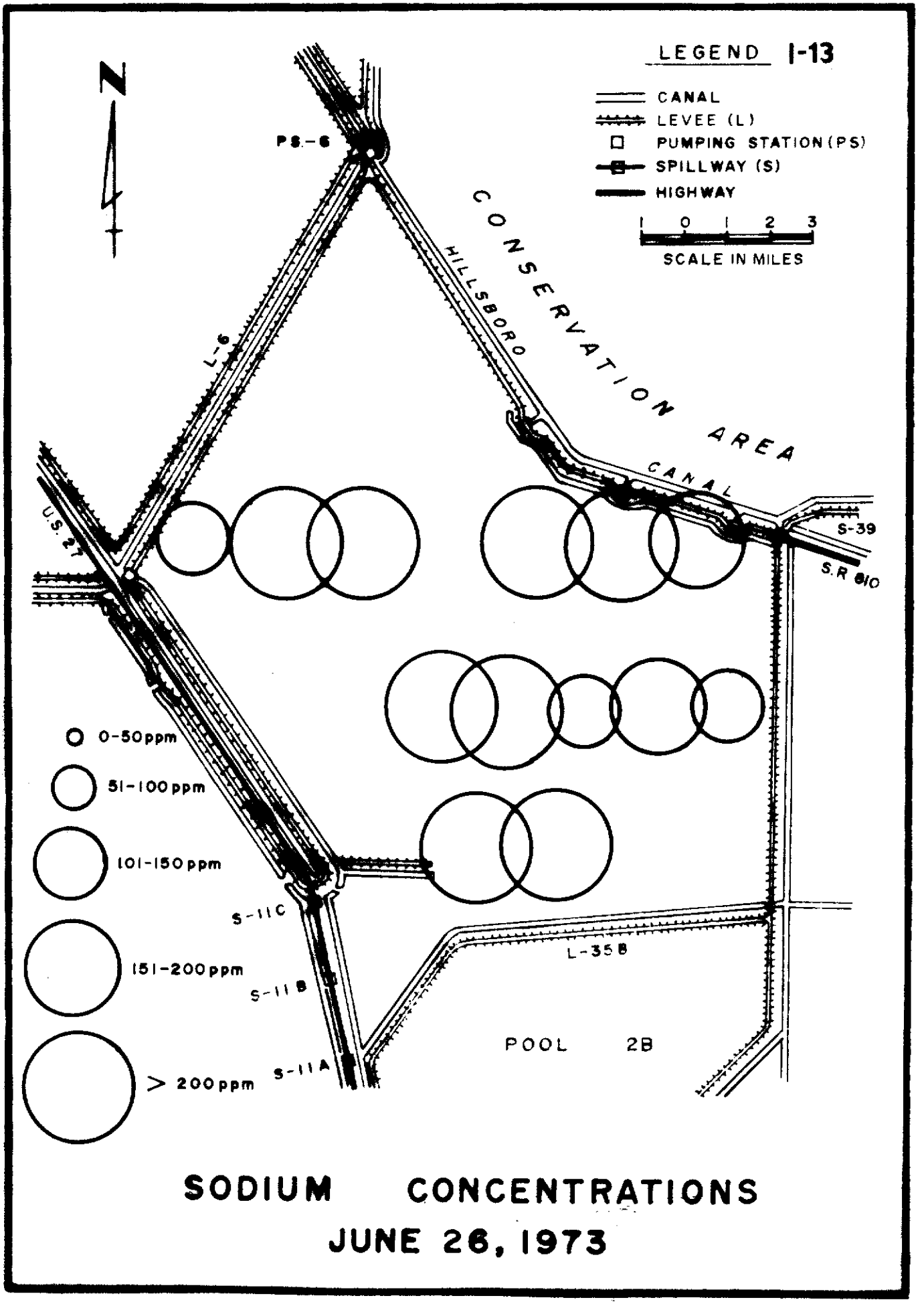
SAMPLING POINTS

JUNE 26, 1973

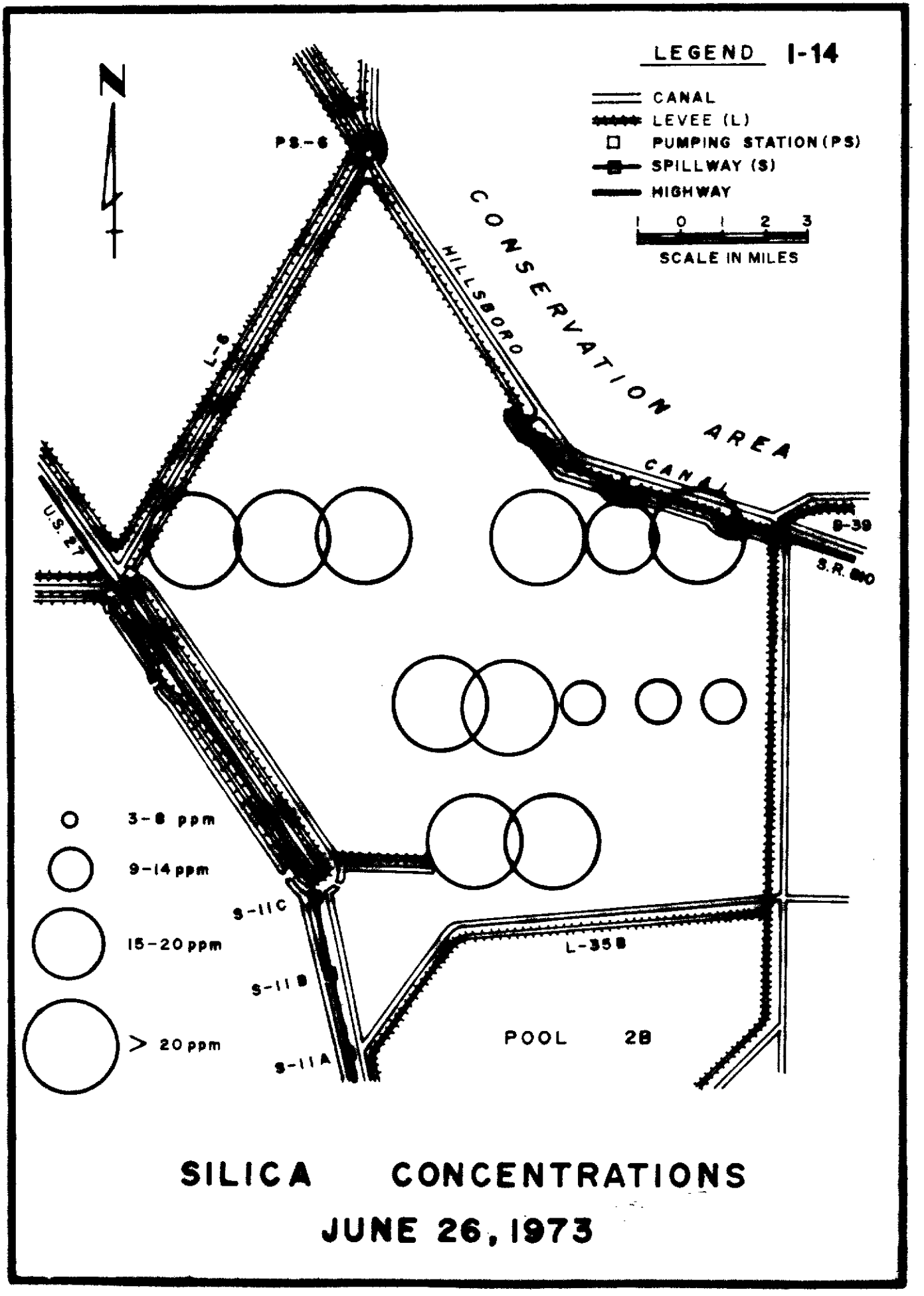


CHLORIDE CONCENTRATIONS

JUNE 26, 1973

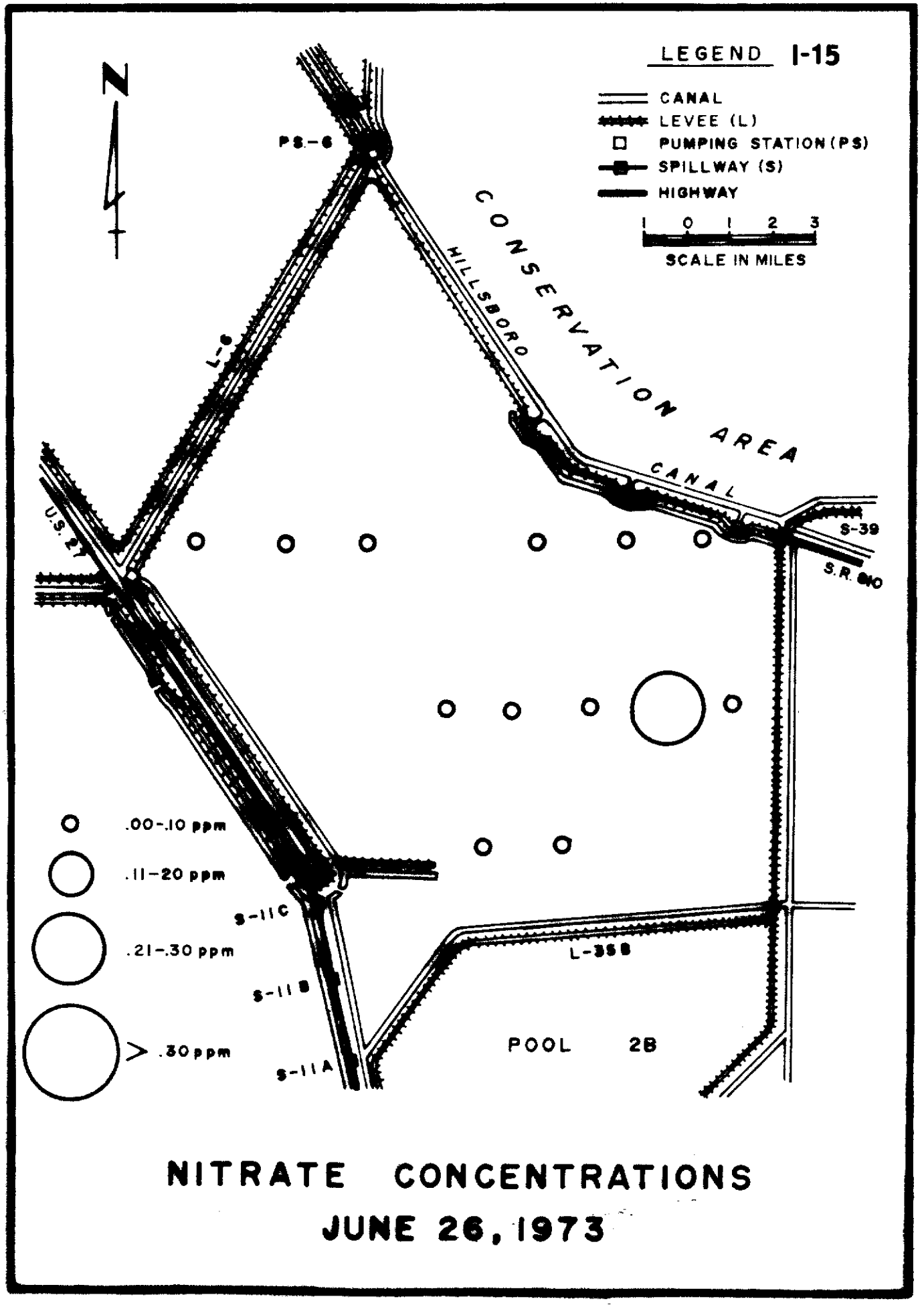


SODIUM CONCENTRATIONS
JUNE 26, 1973

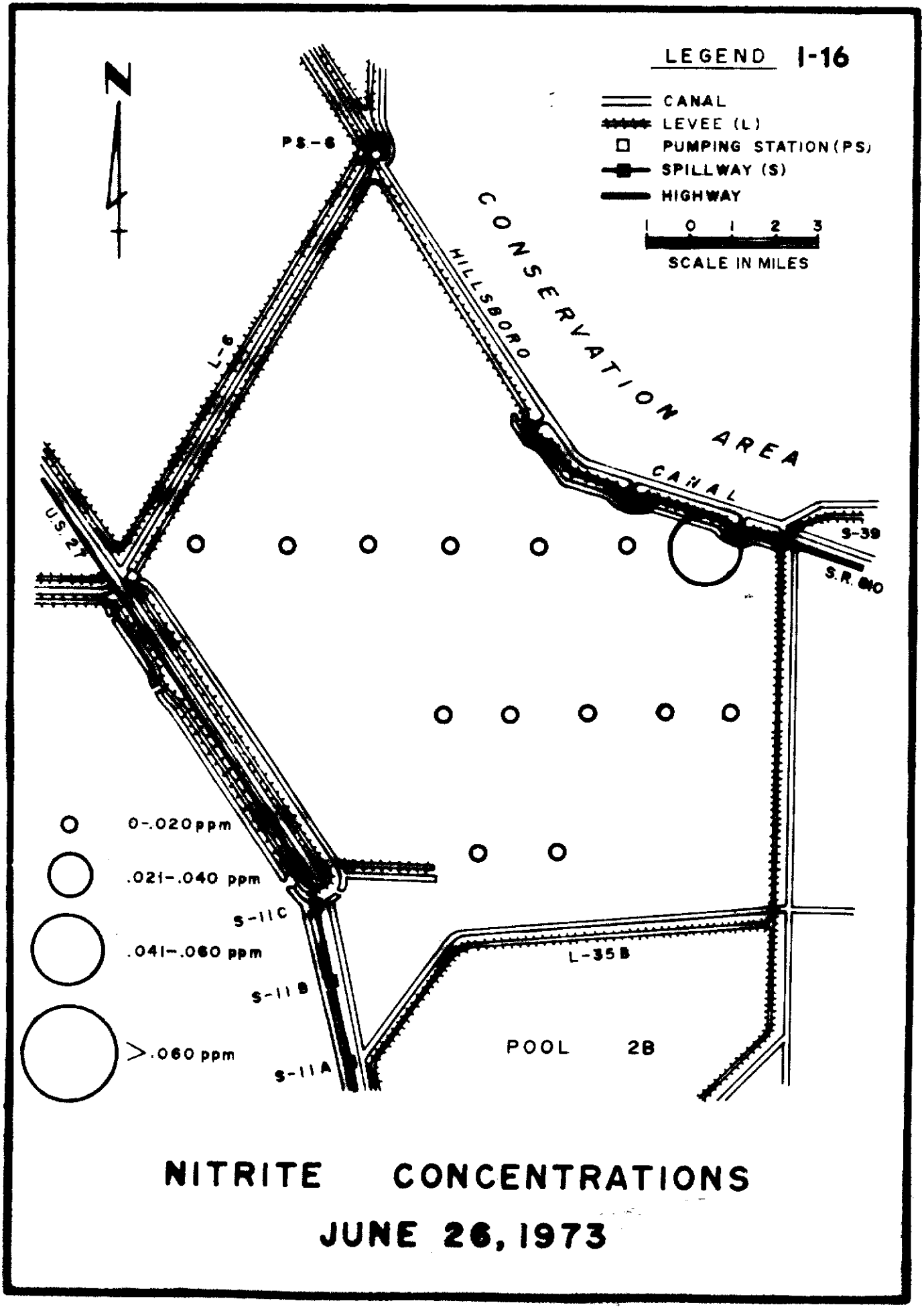


SILICA CONCENTRATIONS

JUNE 26, 1973

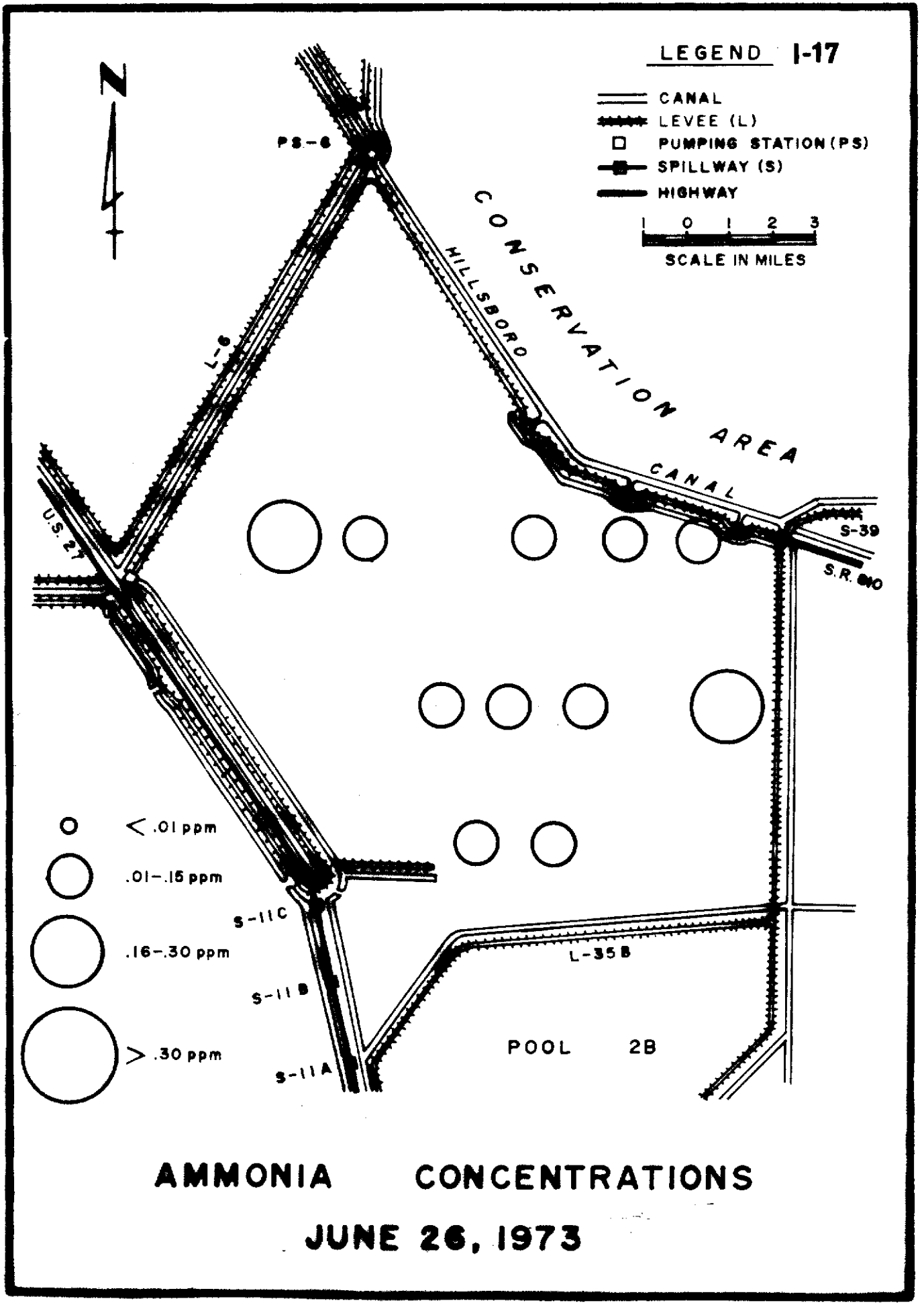


NITRATE CONCENTRATIONS
JUNE 26, 1973



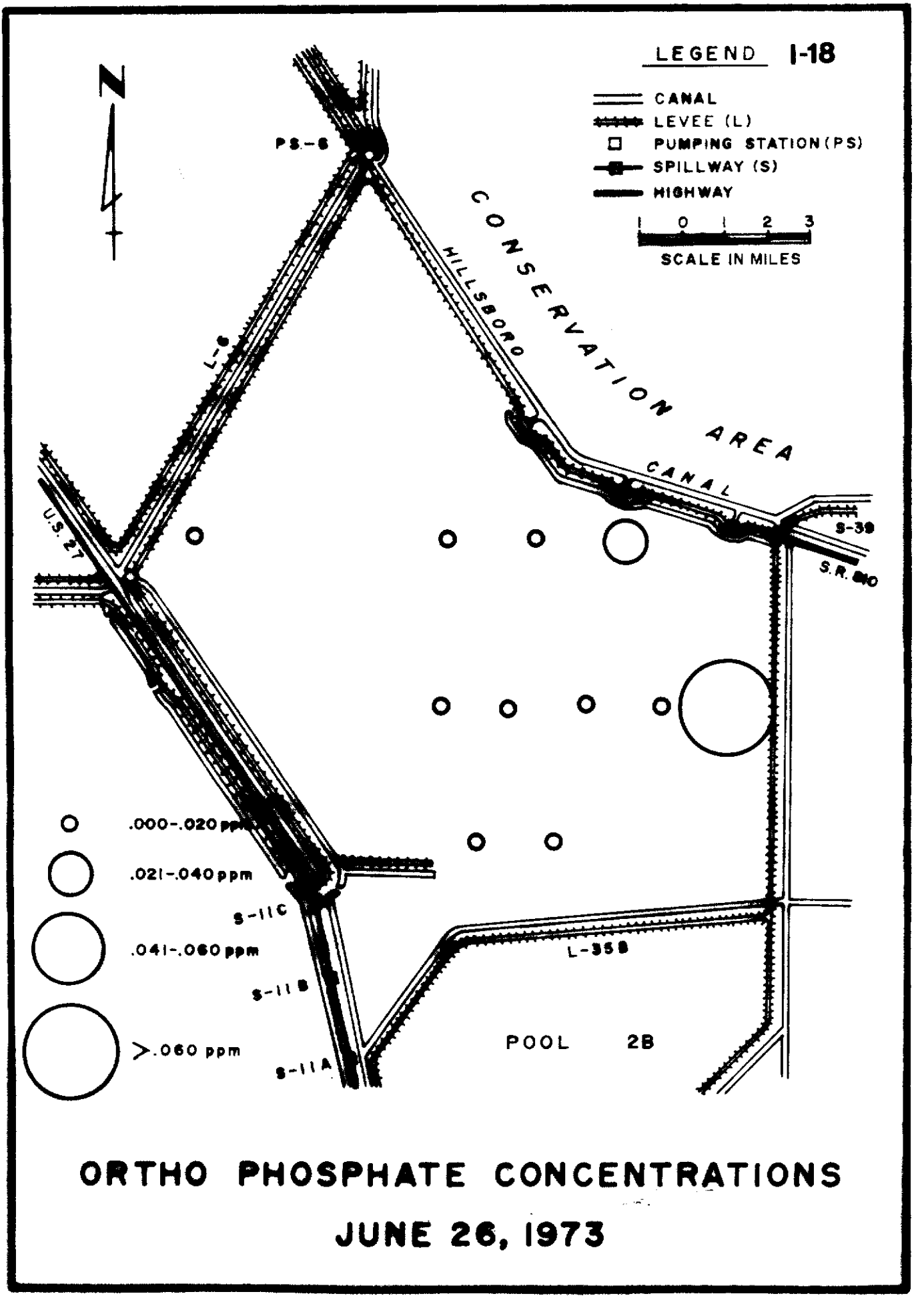
NITRITE CONCENTRATIONS

JUNE 26, 1973



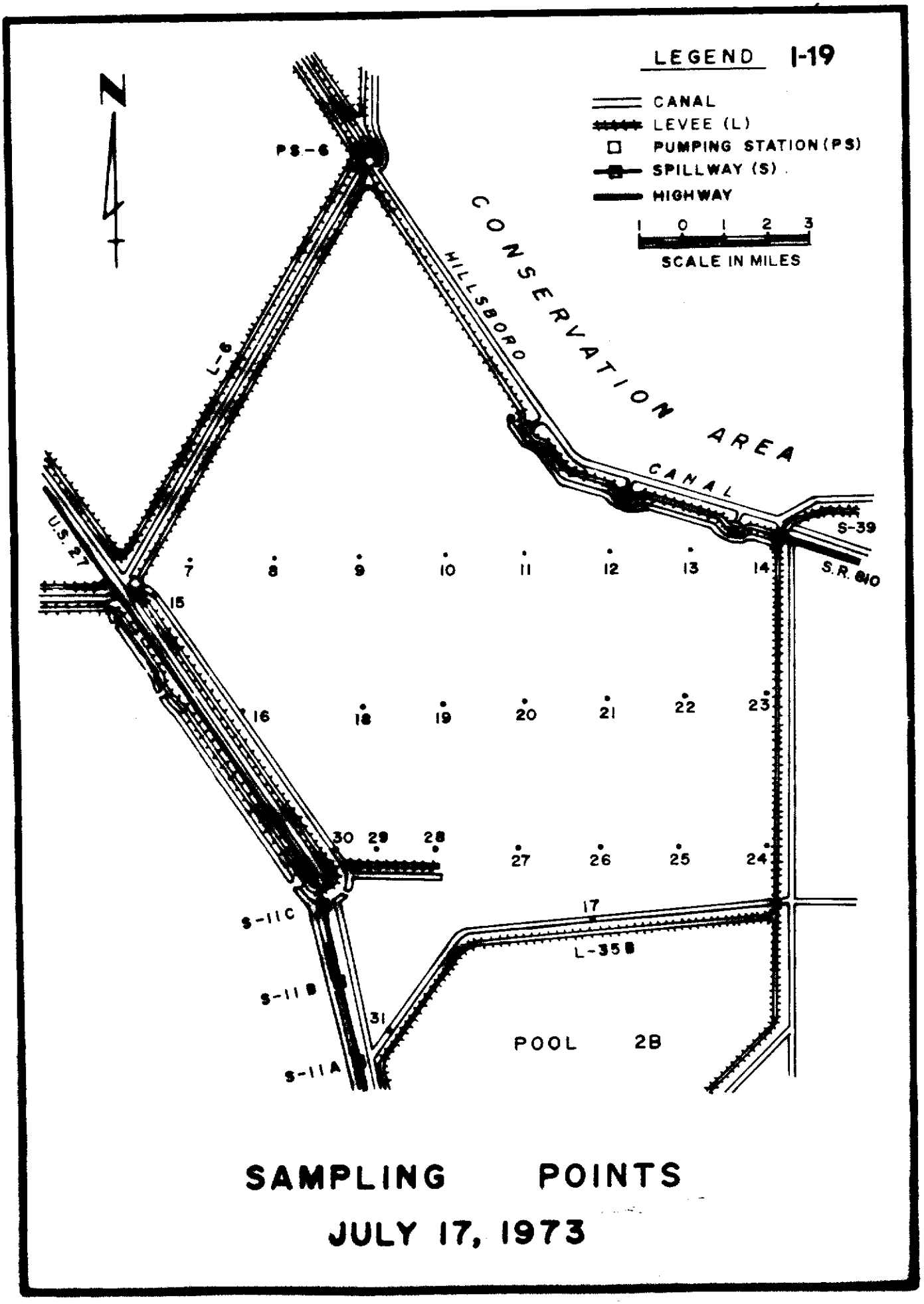
AMMONIA CONCENTRATIONS

JUNE 26, 1973



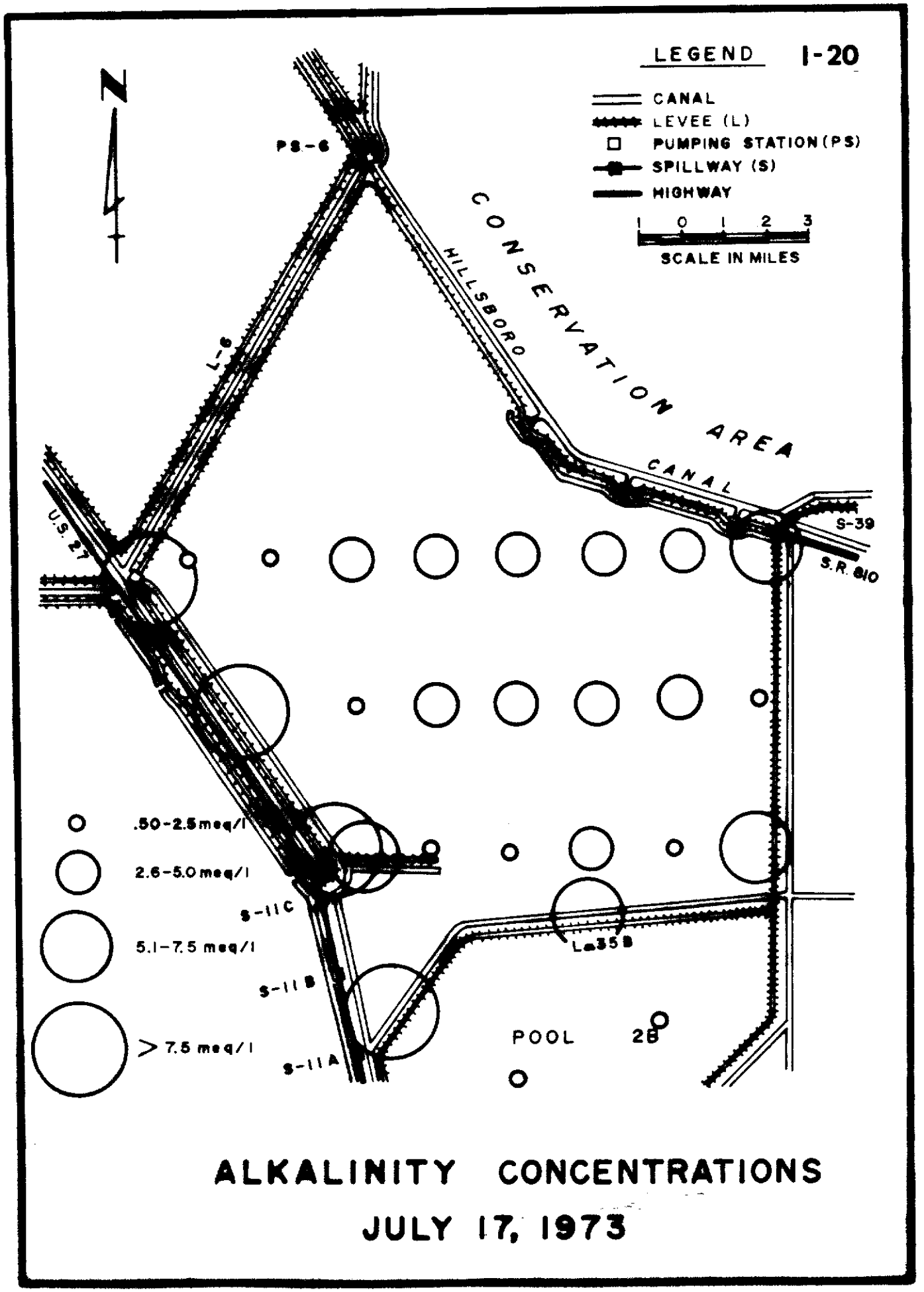
ORTHO PHOSPHATE CONCENTRATIONS

JUNE 26, 1973



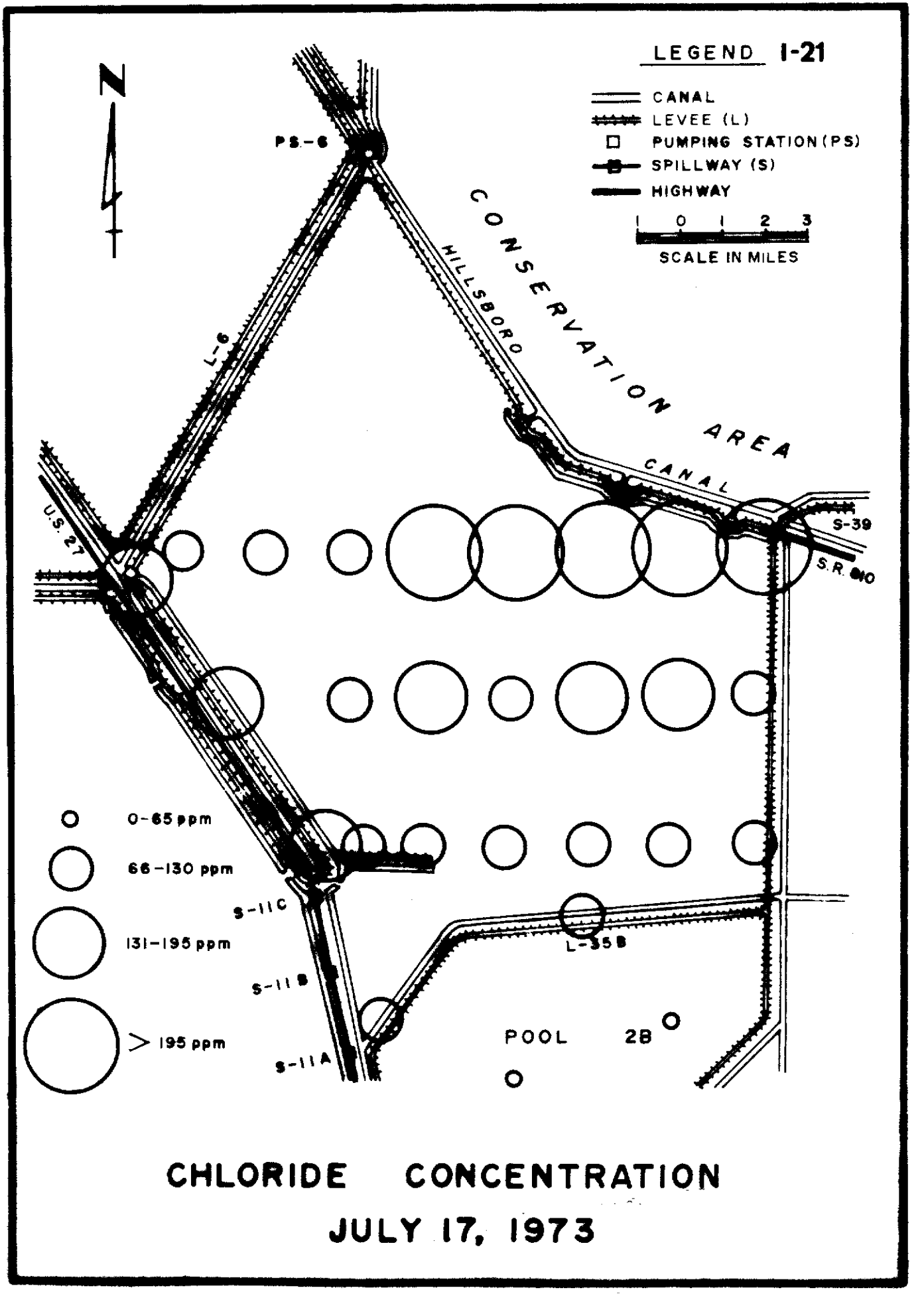
SAMPLING POINTS

JULY 17, 1973



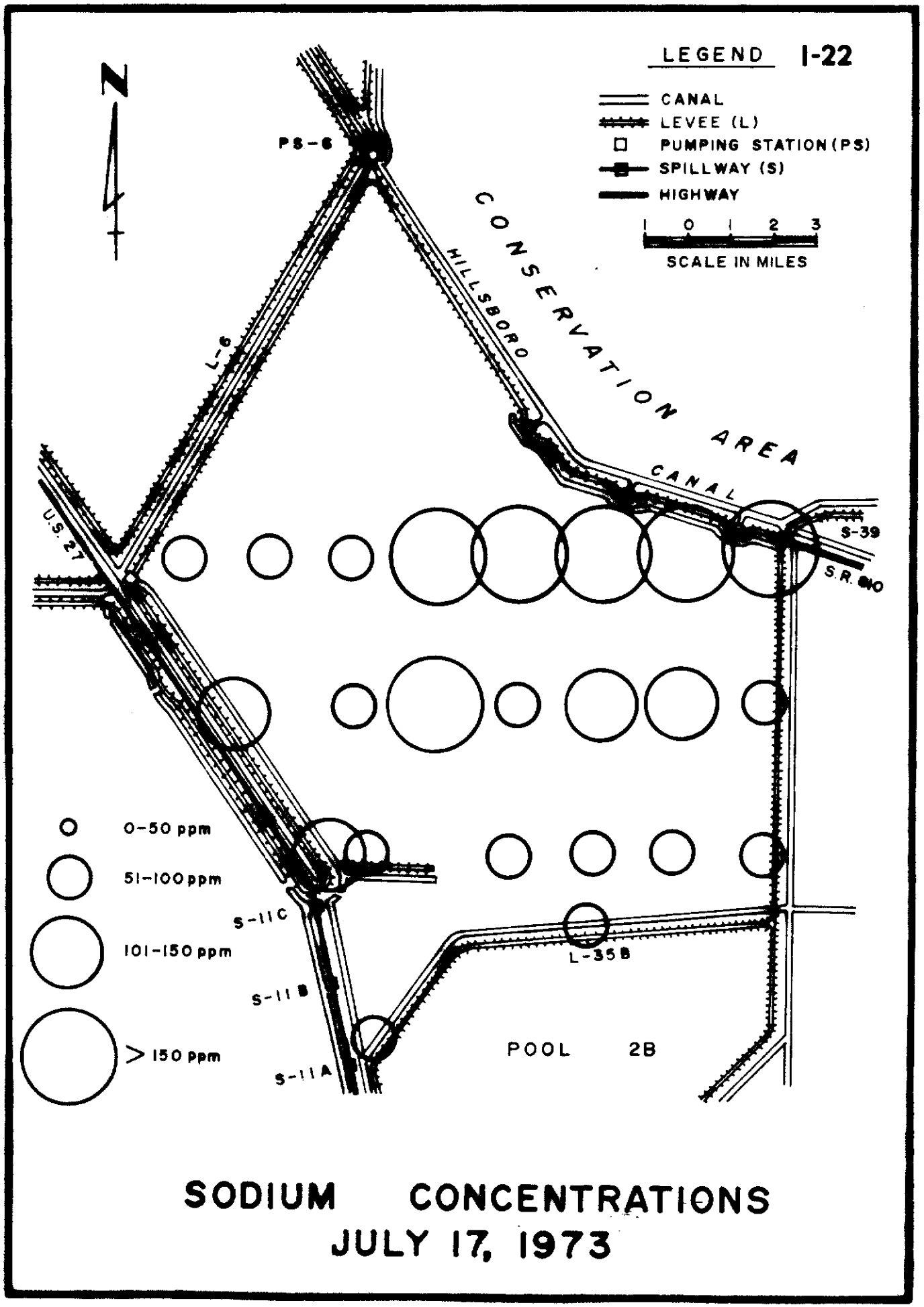
ALKALINITY CONCENTRATIONS

JULY 17, 1973

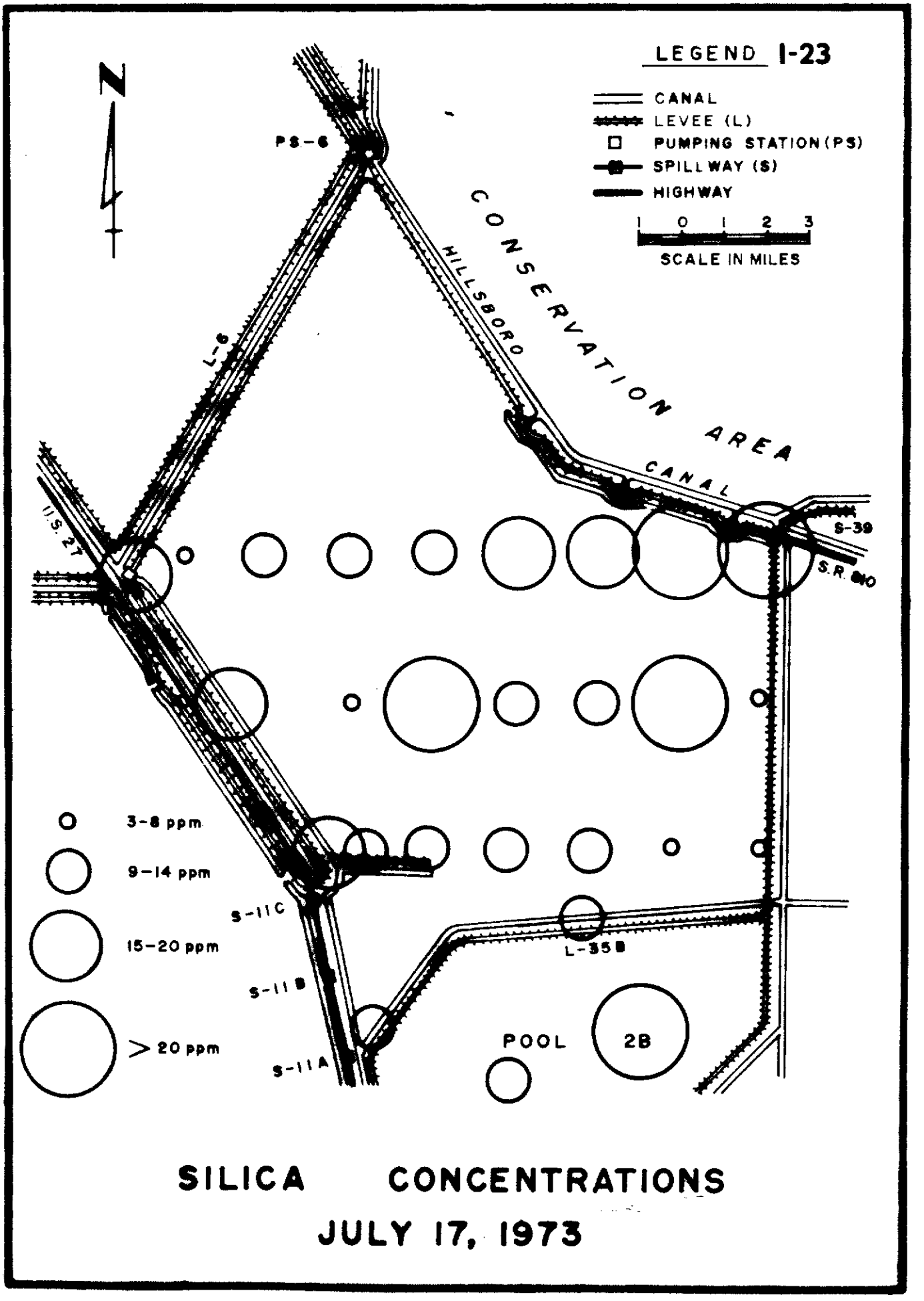


CHLORIDE CONCENTRATION

JULY 17, 1973

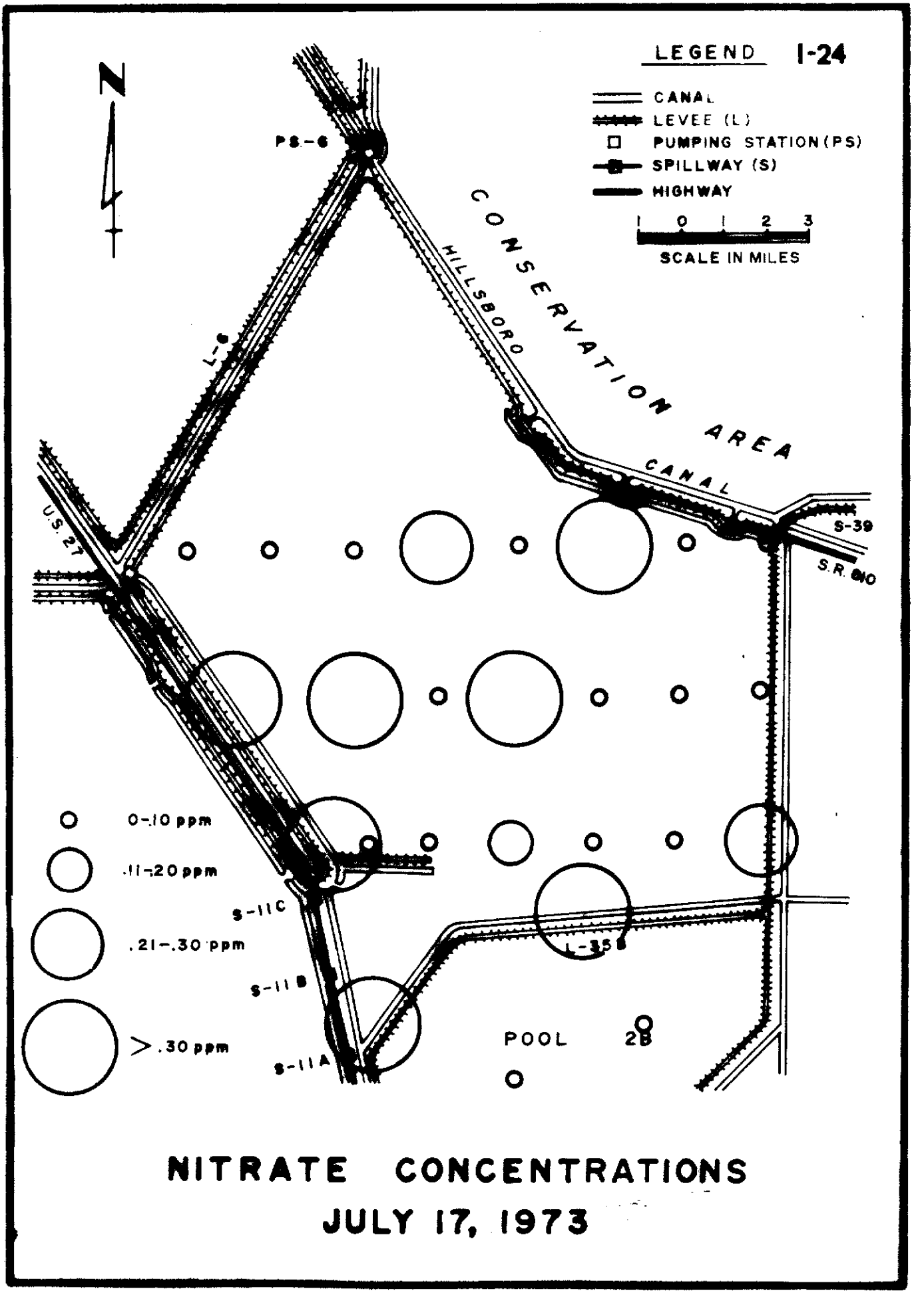


SODIUM CONCENTRATIONS
JULY 17, 1973

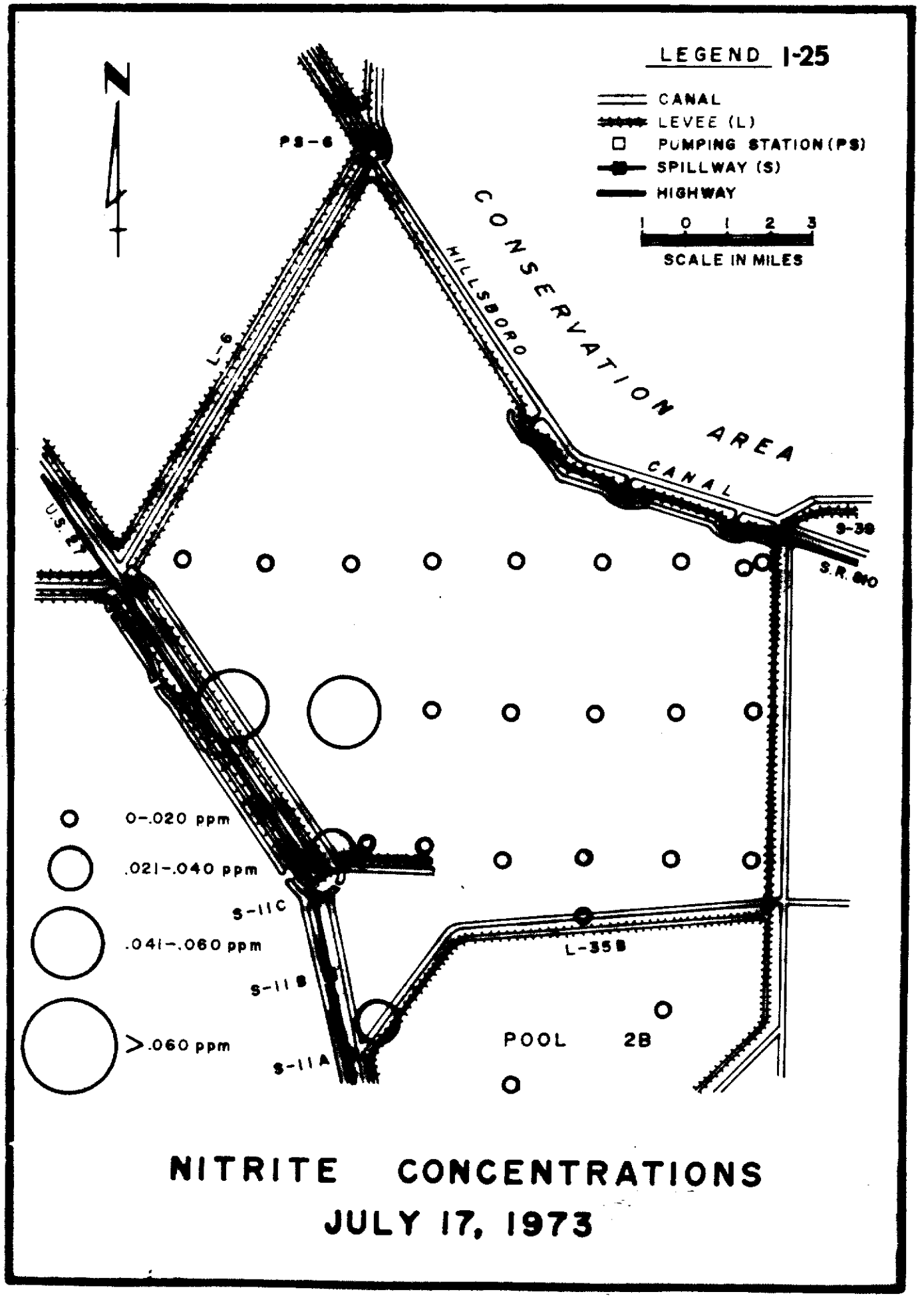


SILICA CONCENTRATIONS

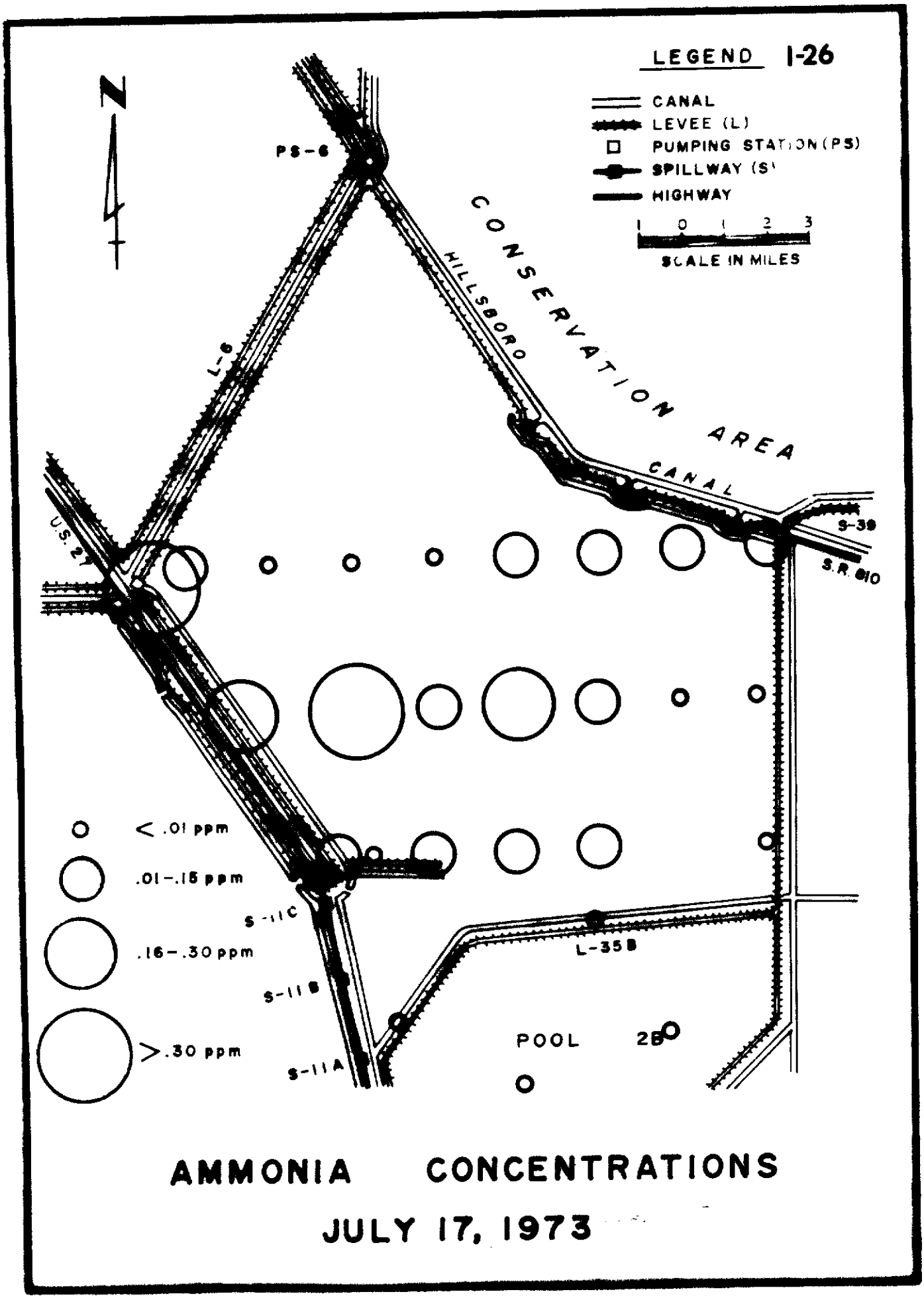
JULY 17, 1973



NITRATE CONCENTRATIONS
JULY 17, 1973

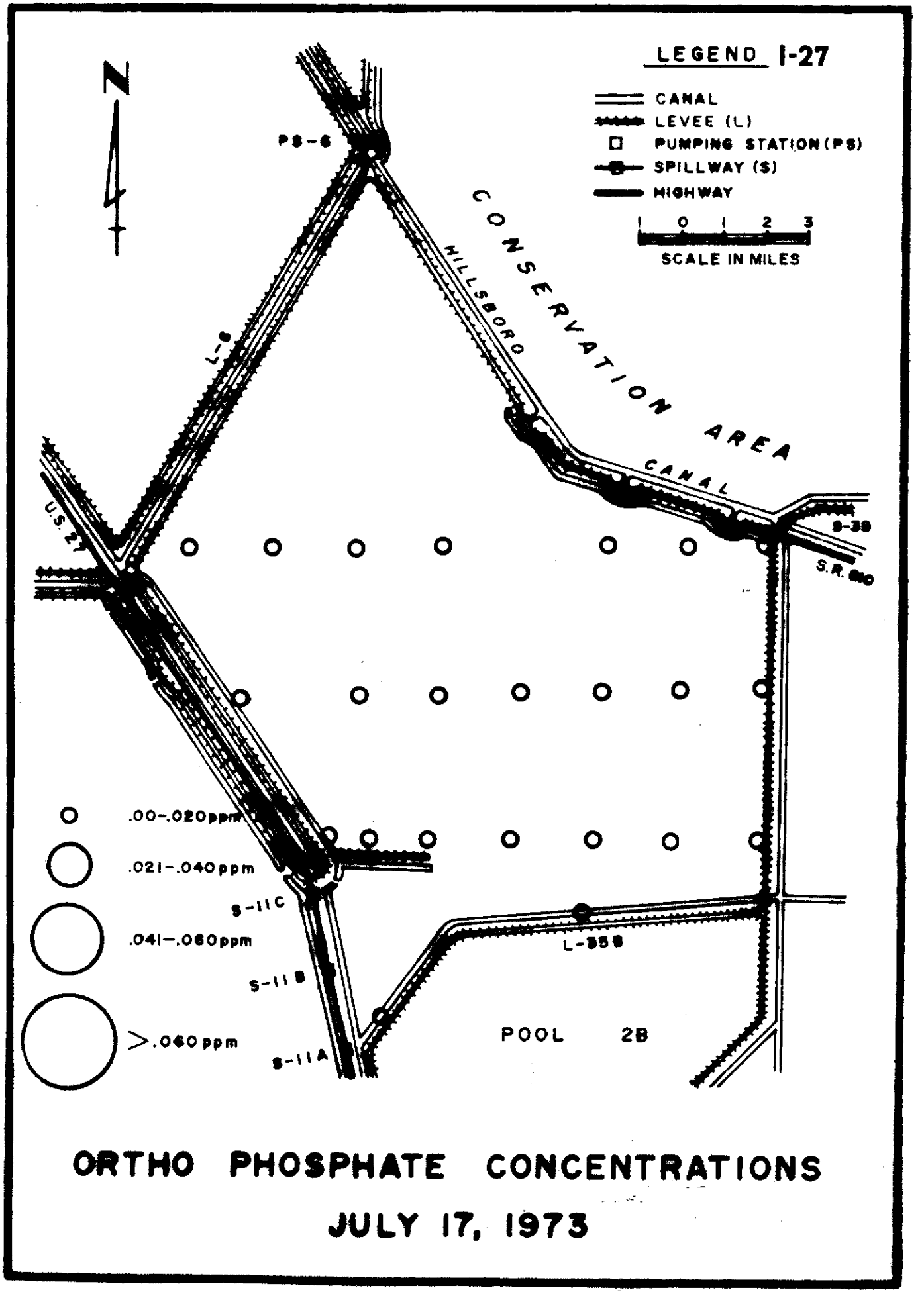


NITRITE CONCENTRATIONS
JULY 17, 1973



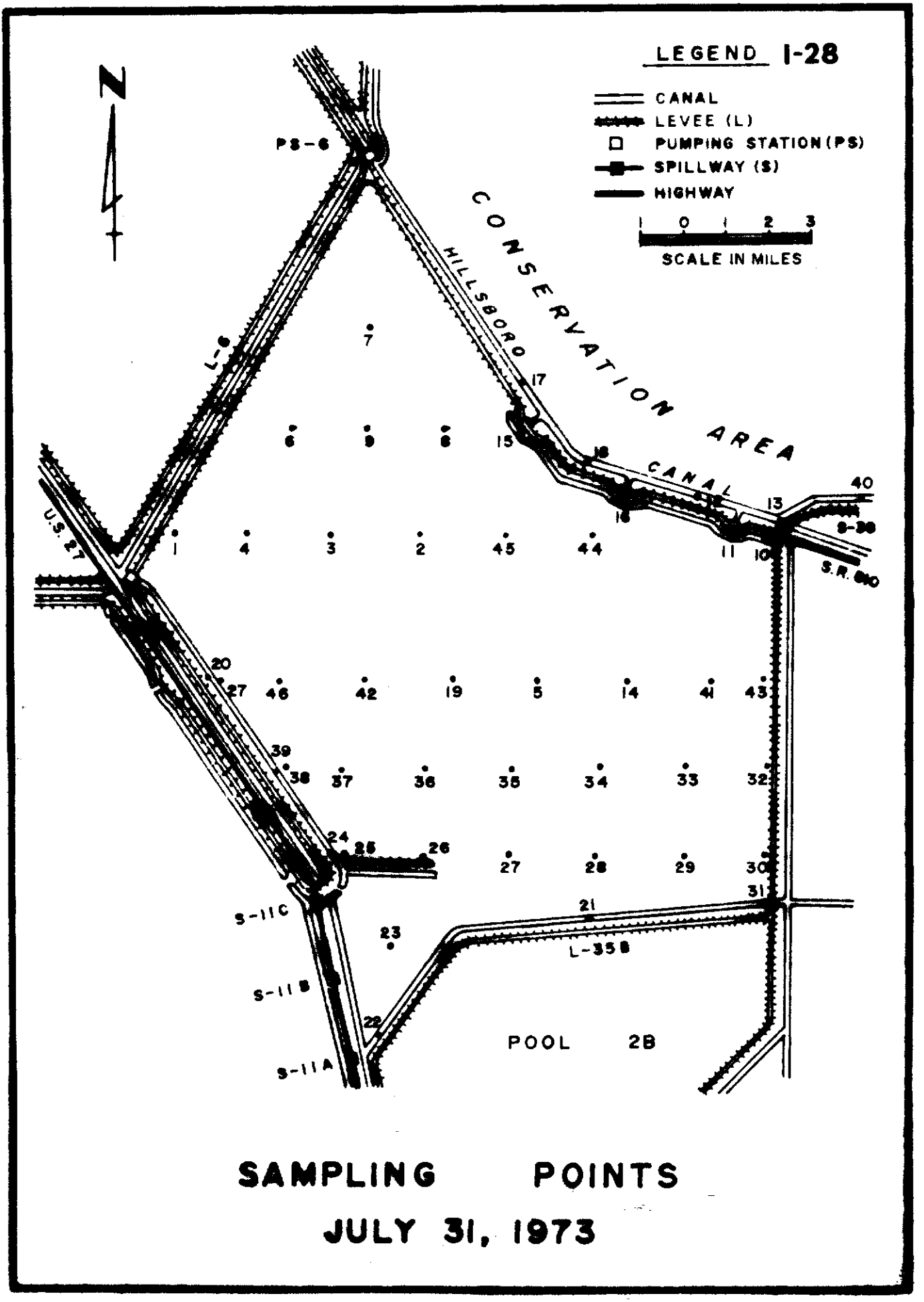
AMMONIA CONCENTRATIONS

JULY 17, 1973



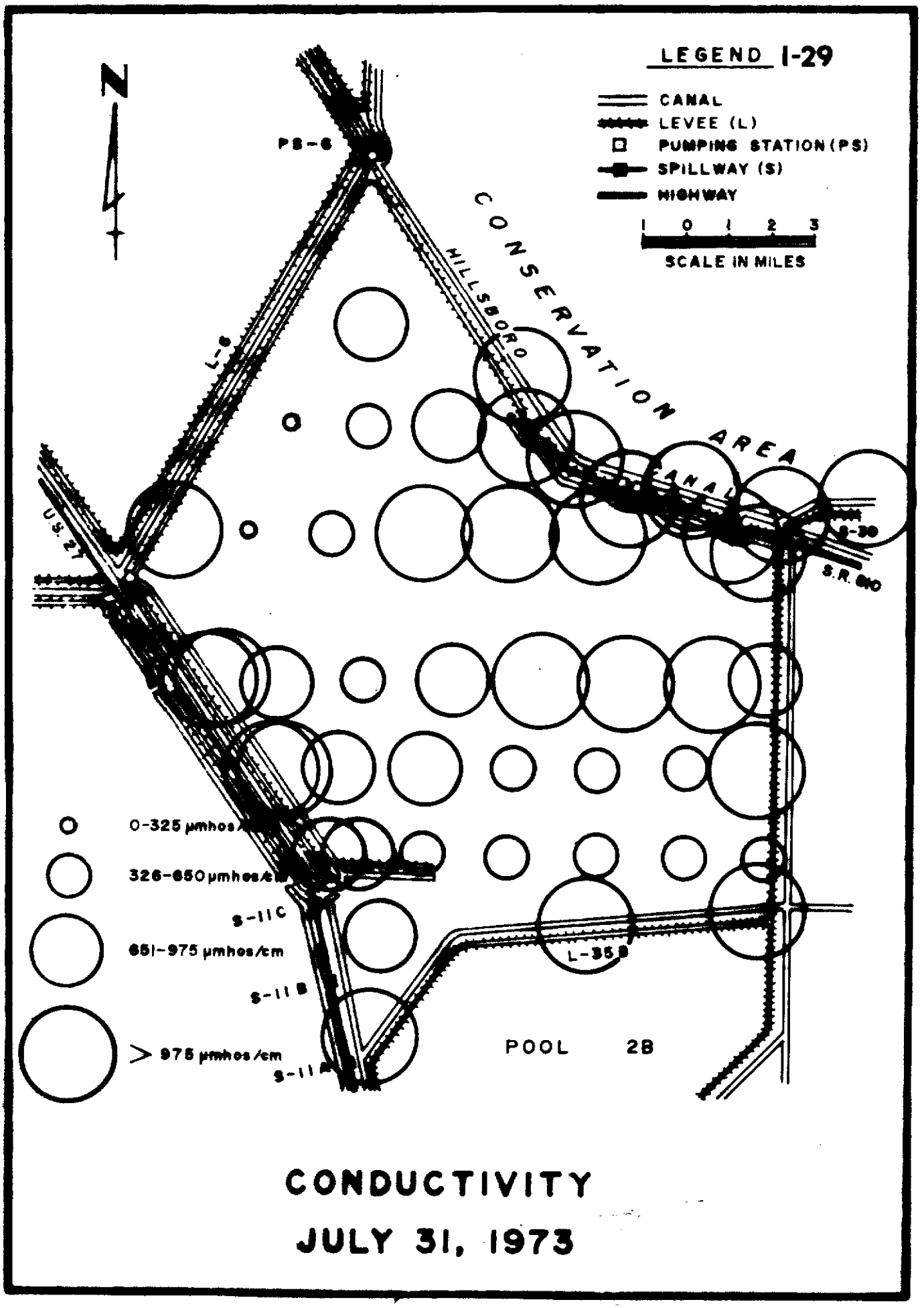
ORTHO PHOSPHATE CONCENTRATIONS

JULY 17, 1973



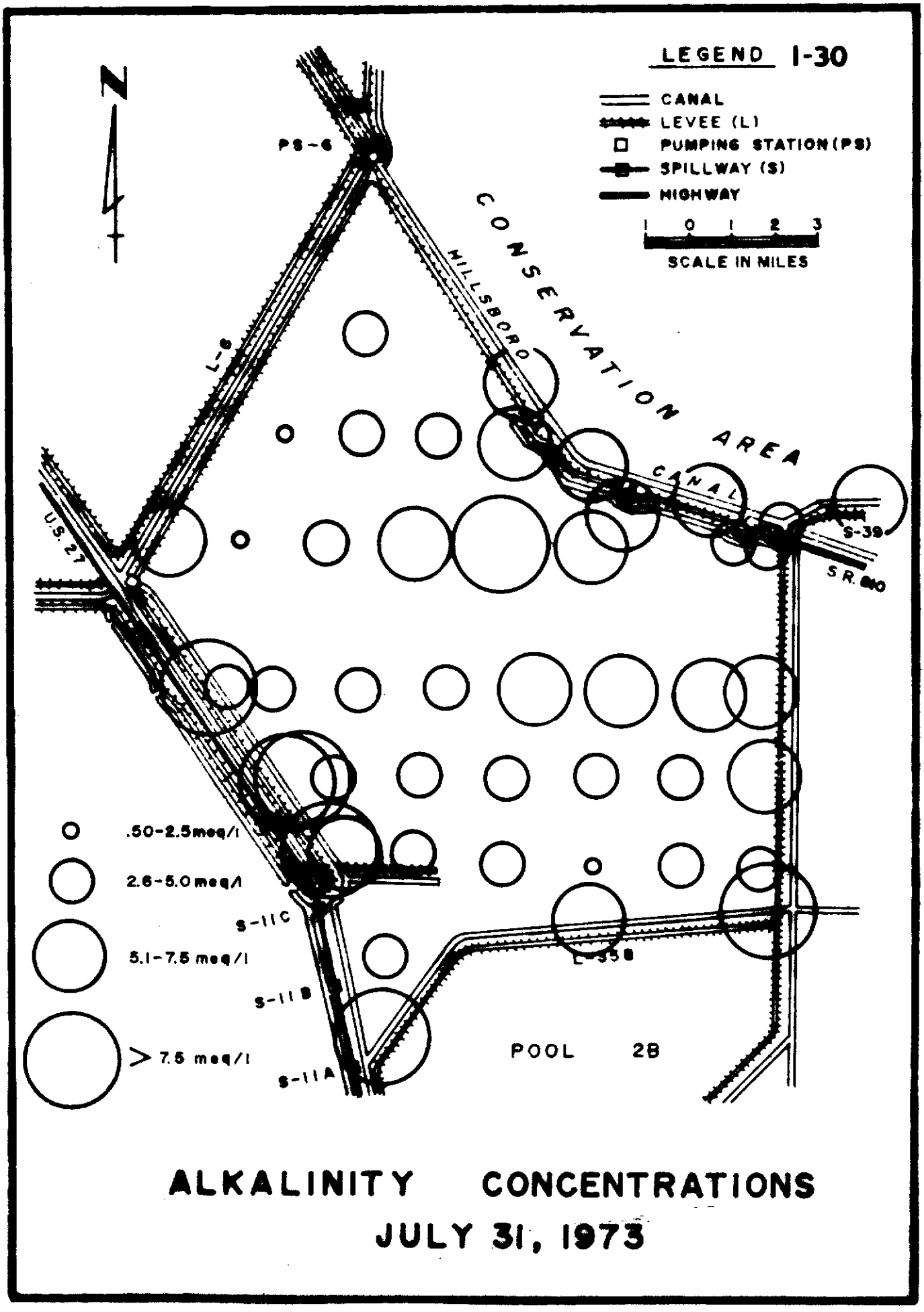
SAMPLING POINTS

JULY 31, 1973



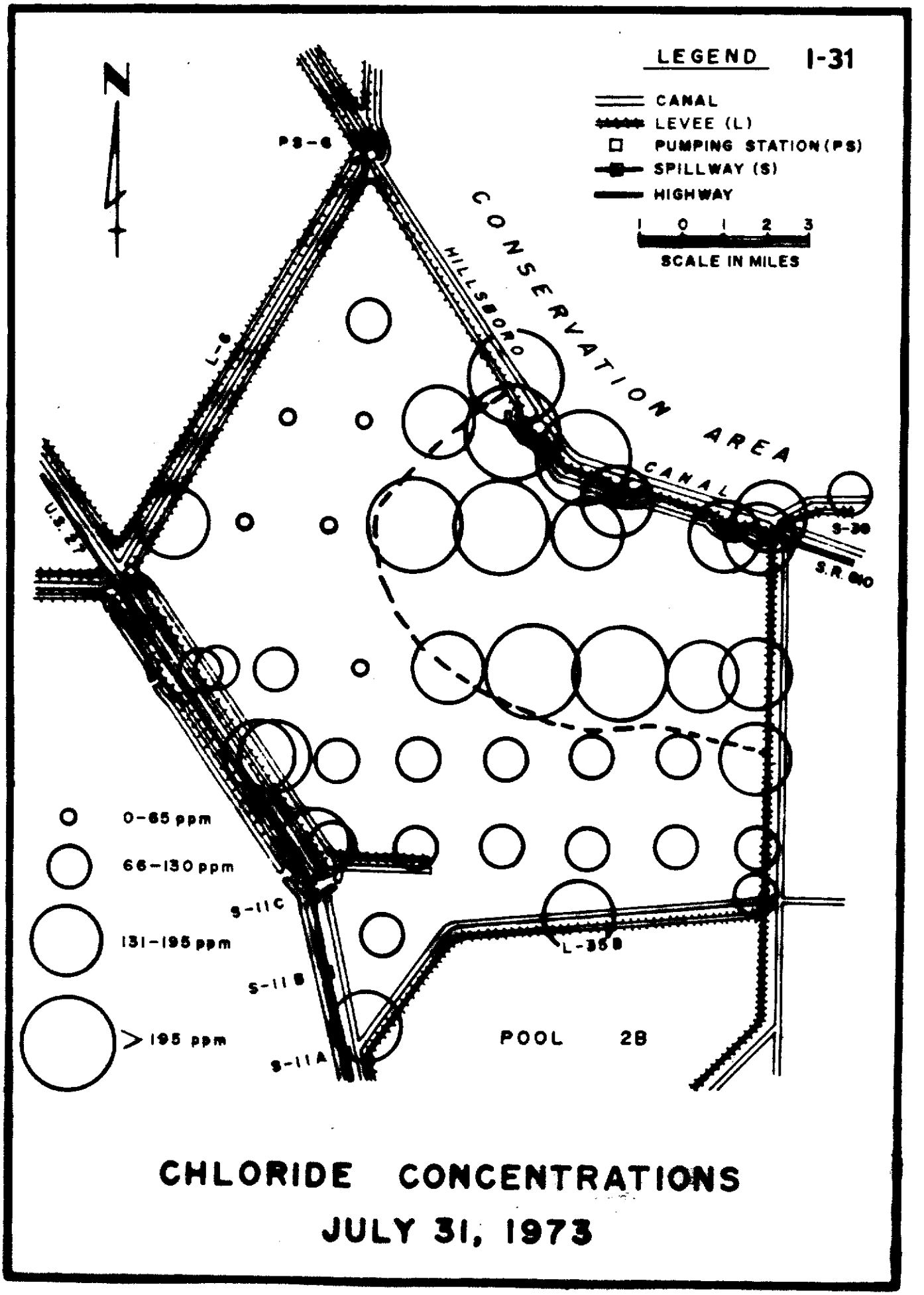
CONDUCTIVITY

JULY 31, 1973



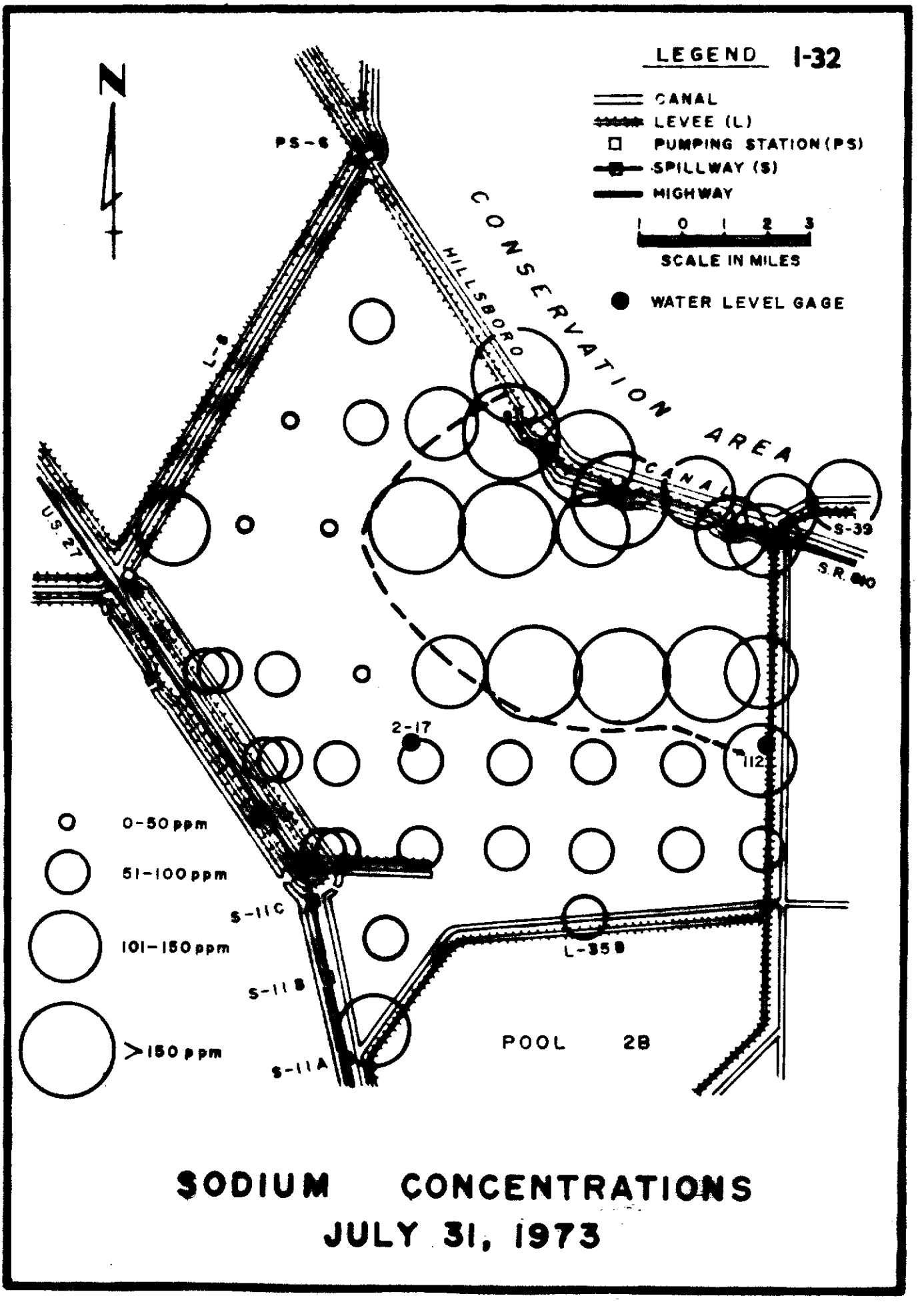
ALKALINITY CONCENTRATIONS

JULY 31, 1973

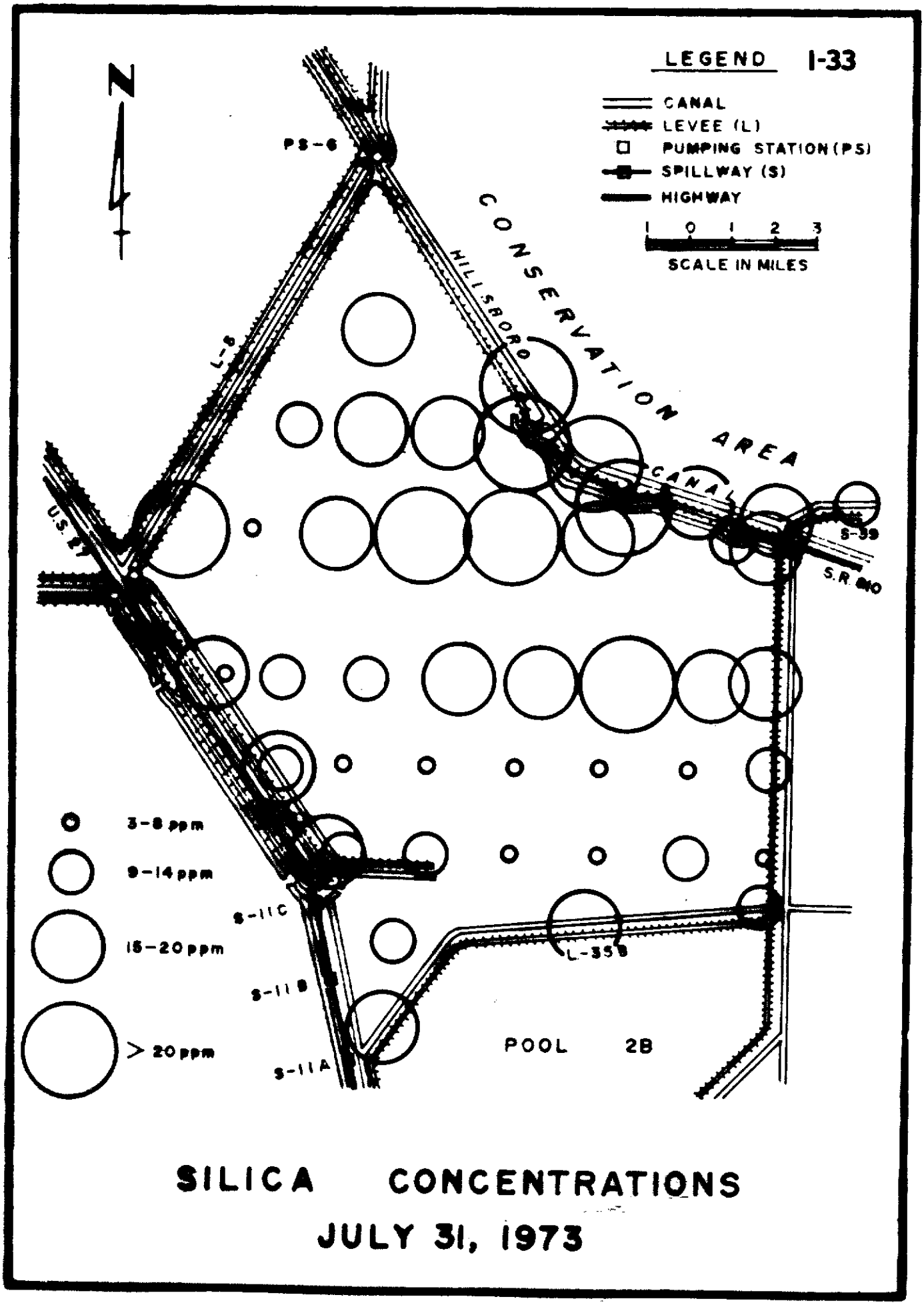


CHLORIDE CONCENTRATIONS

JULY 31, 1973

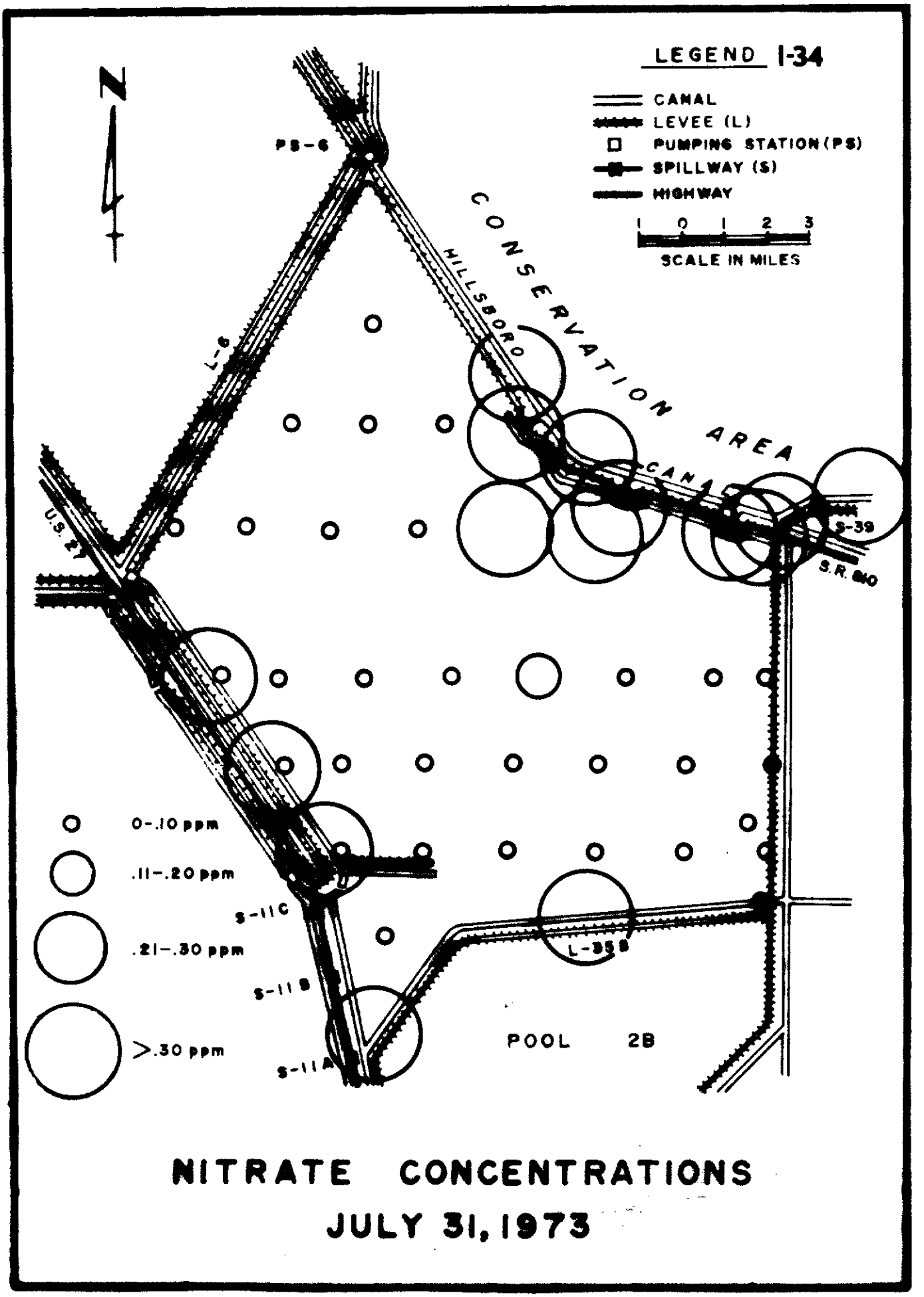


SODIUM CONCENTRATIONS
JULY 31, 1973

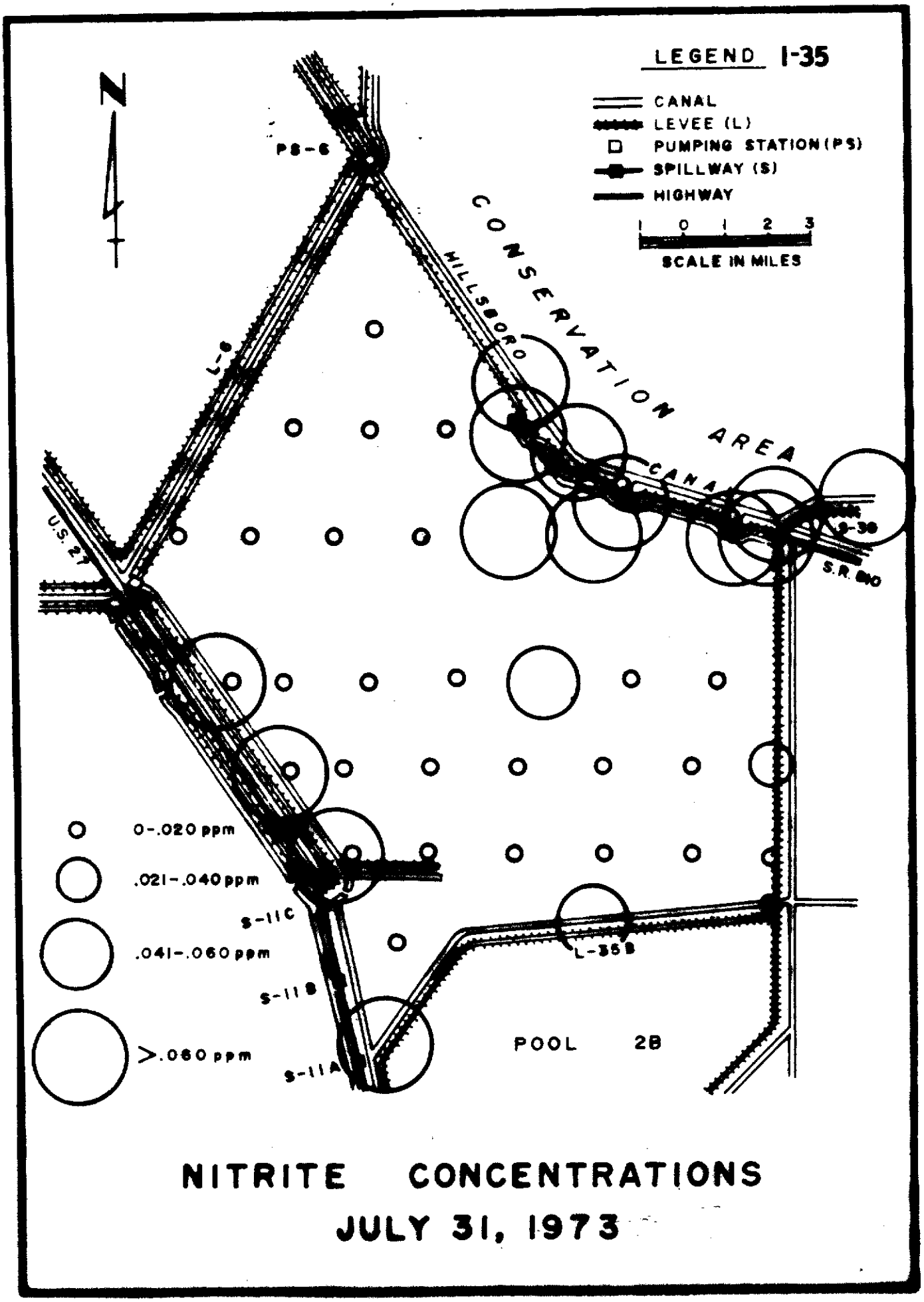


SILICA CONCENTRATIONS

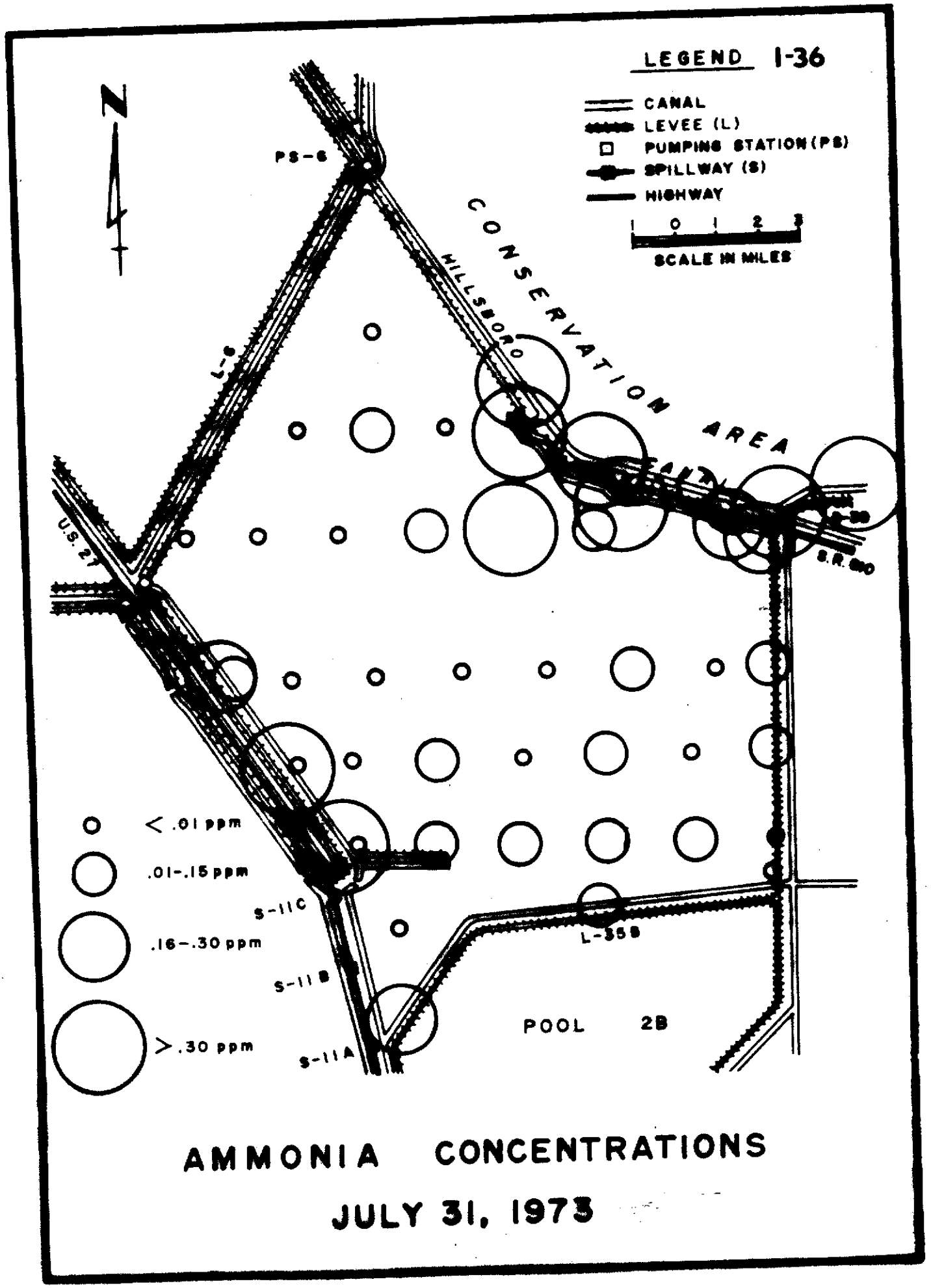
JULY 31, 1973



NITRATE CONCENTRATIONS
JULY 31, 1973

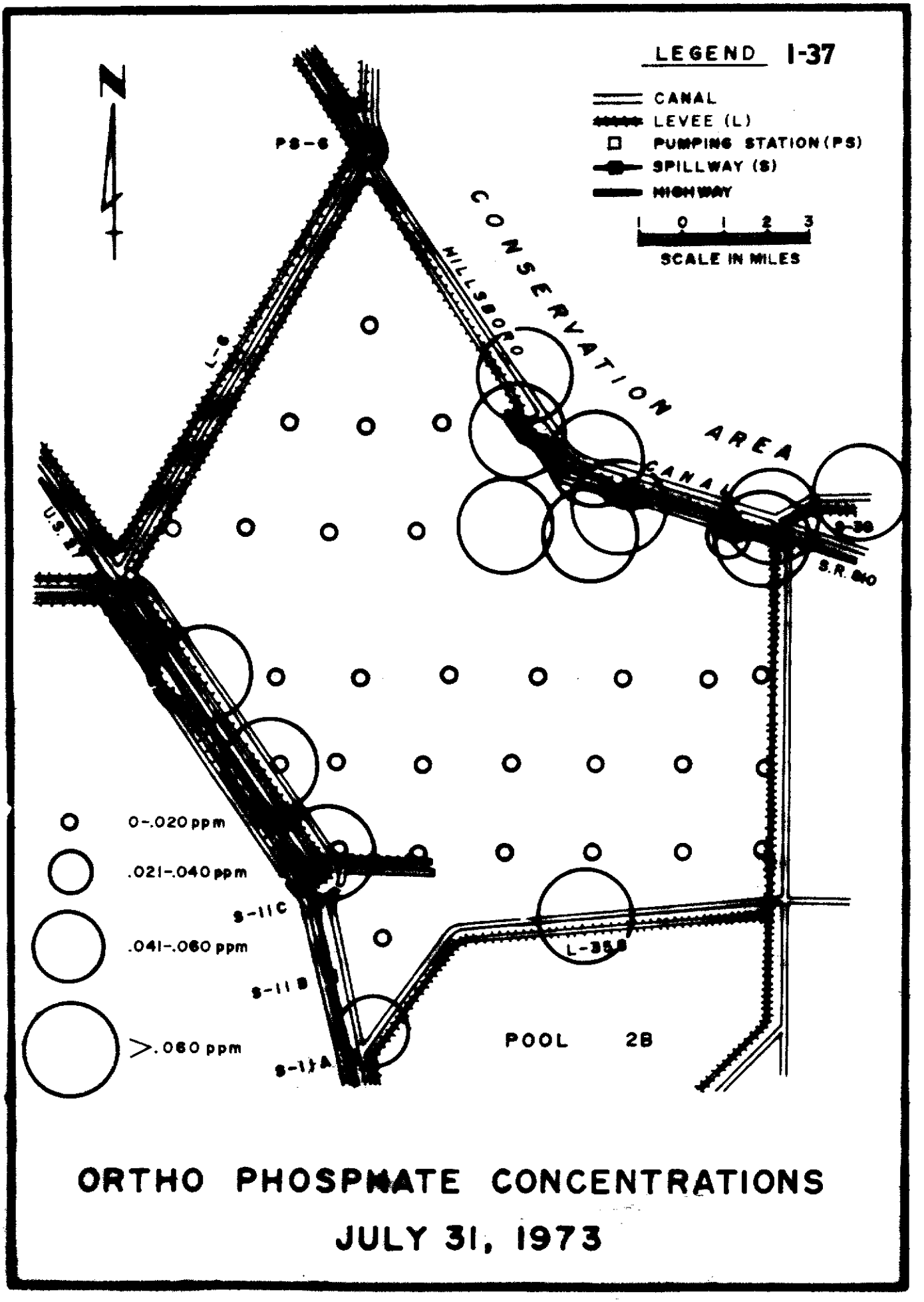


NITRITE CONCENTRATIONS
JULY 31, 1973



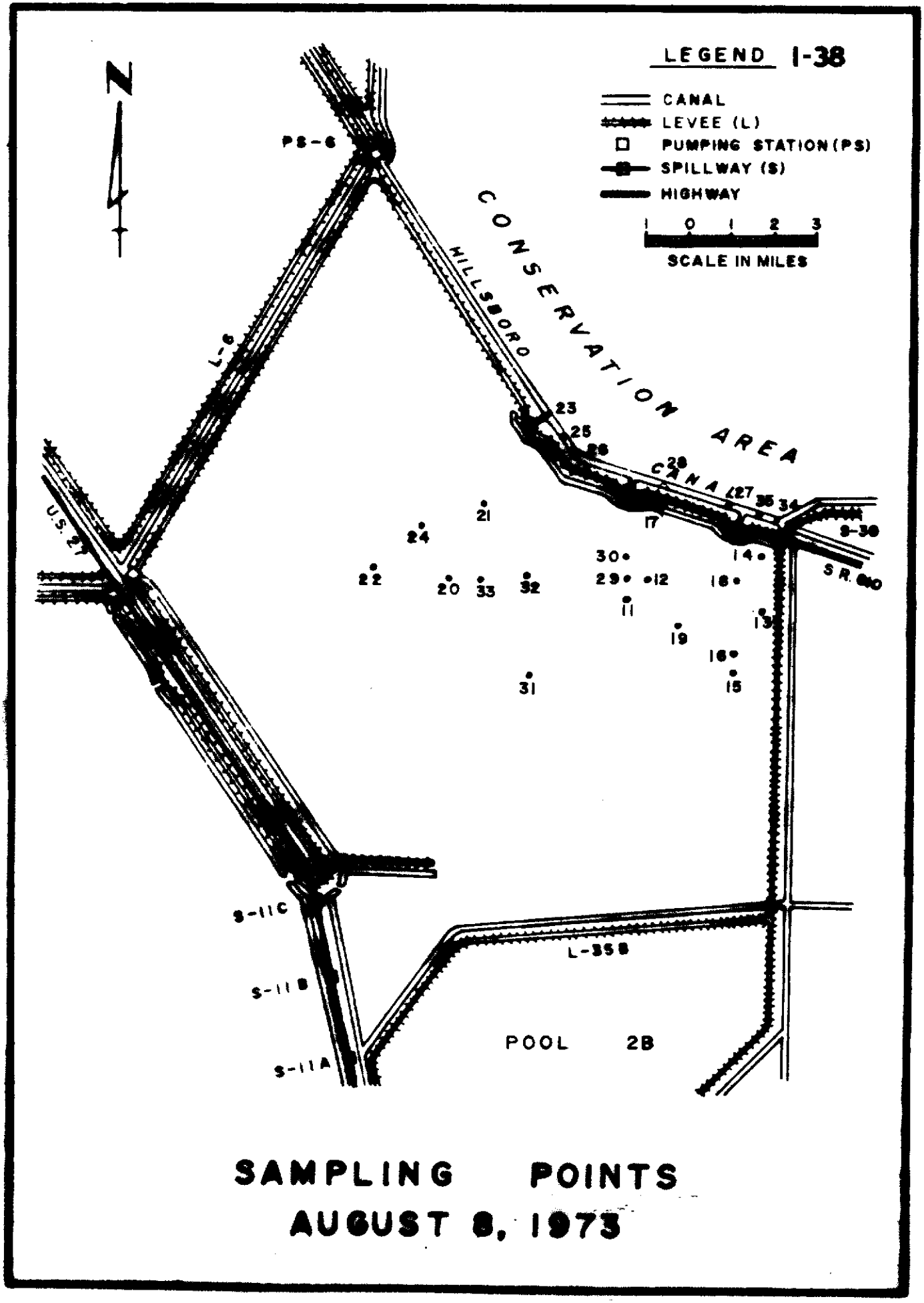
AMMONIA CONCENTRATIONS

JULY 31, 1973

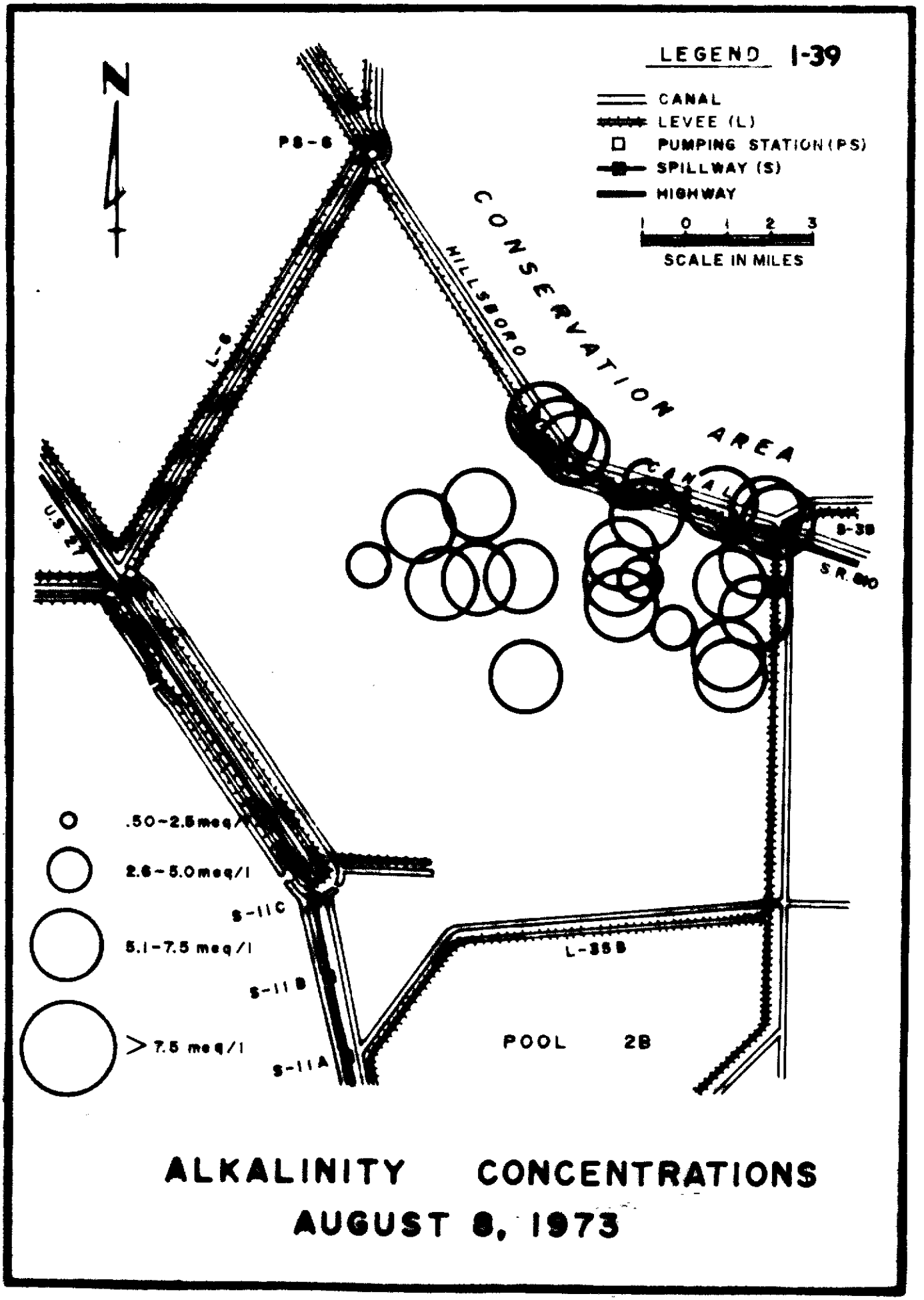


ORTHO PHOSPHATE CONCENTRATIONS

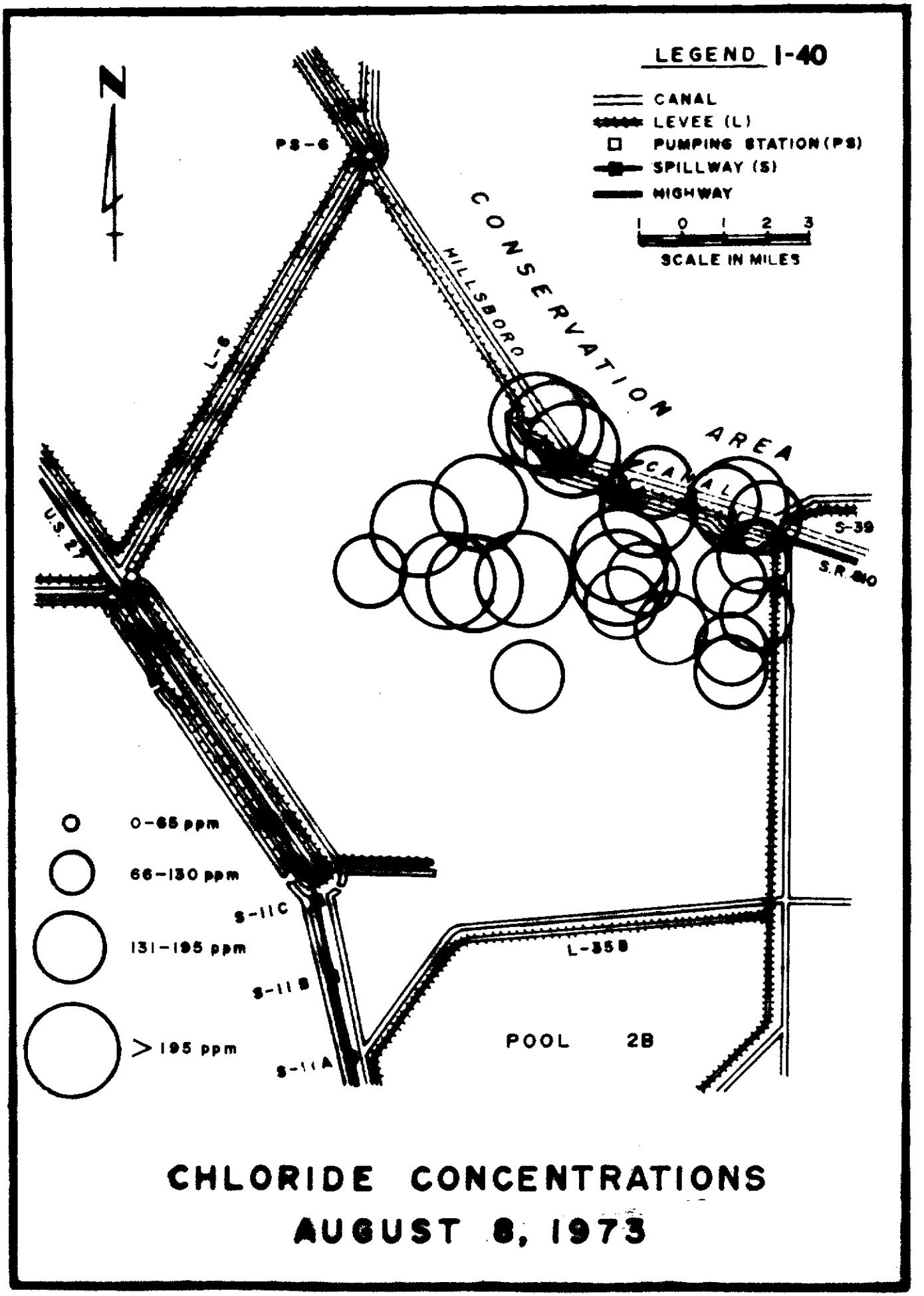
JULY 31, 1973



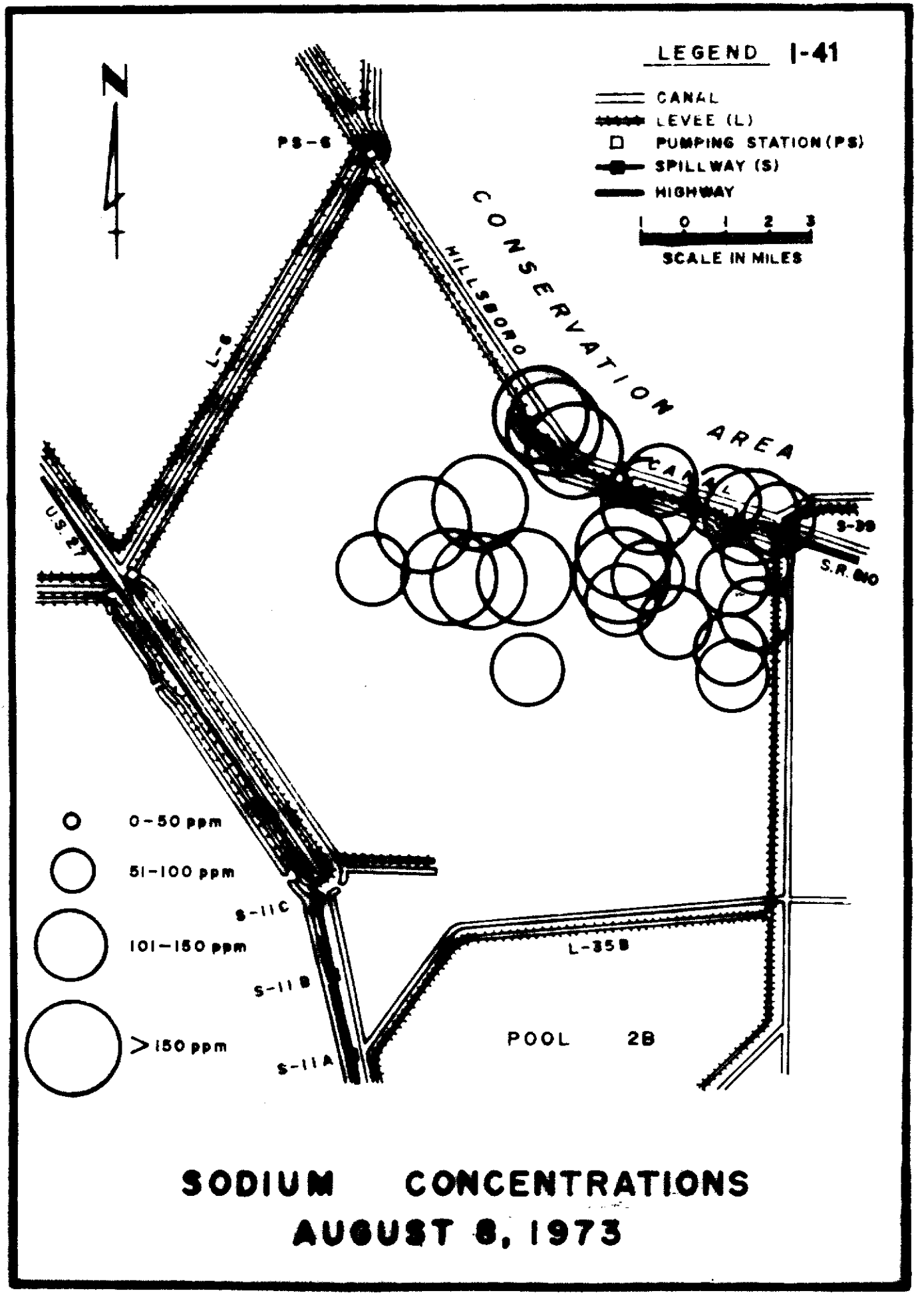
SAMPLING POINTS
AUGUST 8, 1973



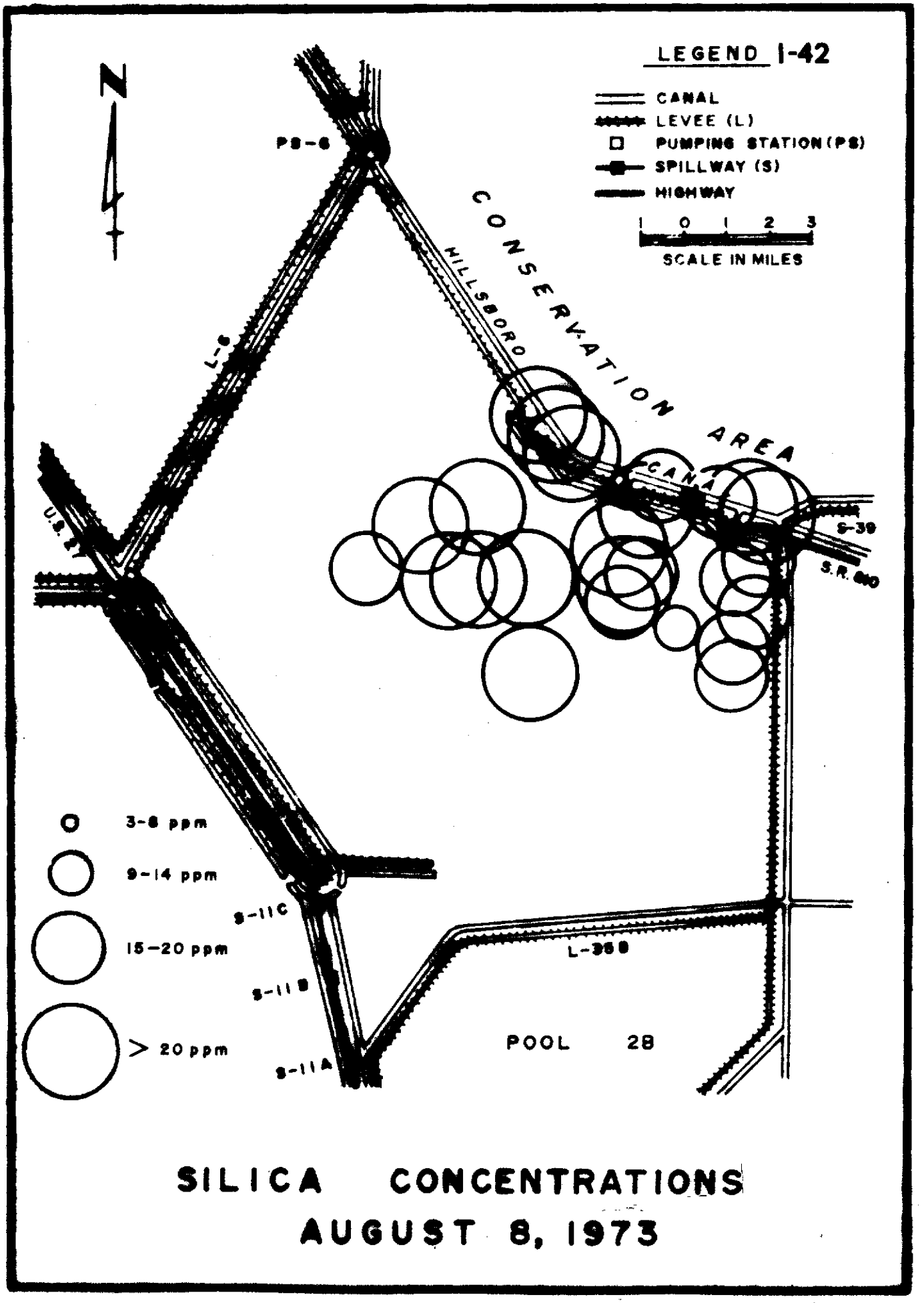
ALKALINITY CONCENTRATIONS
AUGUST 8, 1973



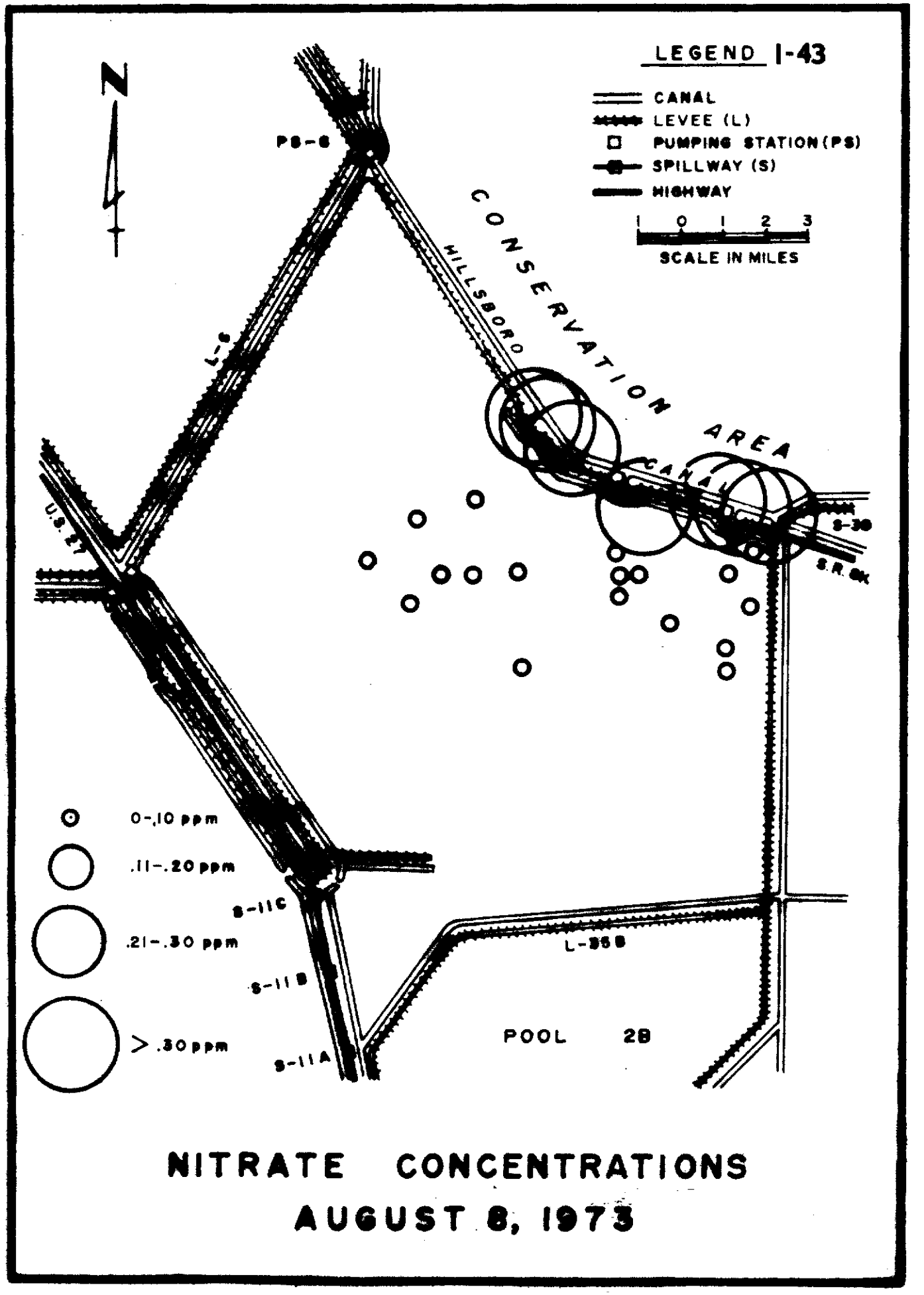
CHLORIDE CONCENTRATIONS
AUGUST 8, 1973



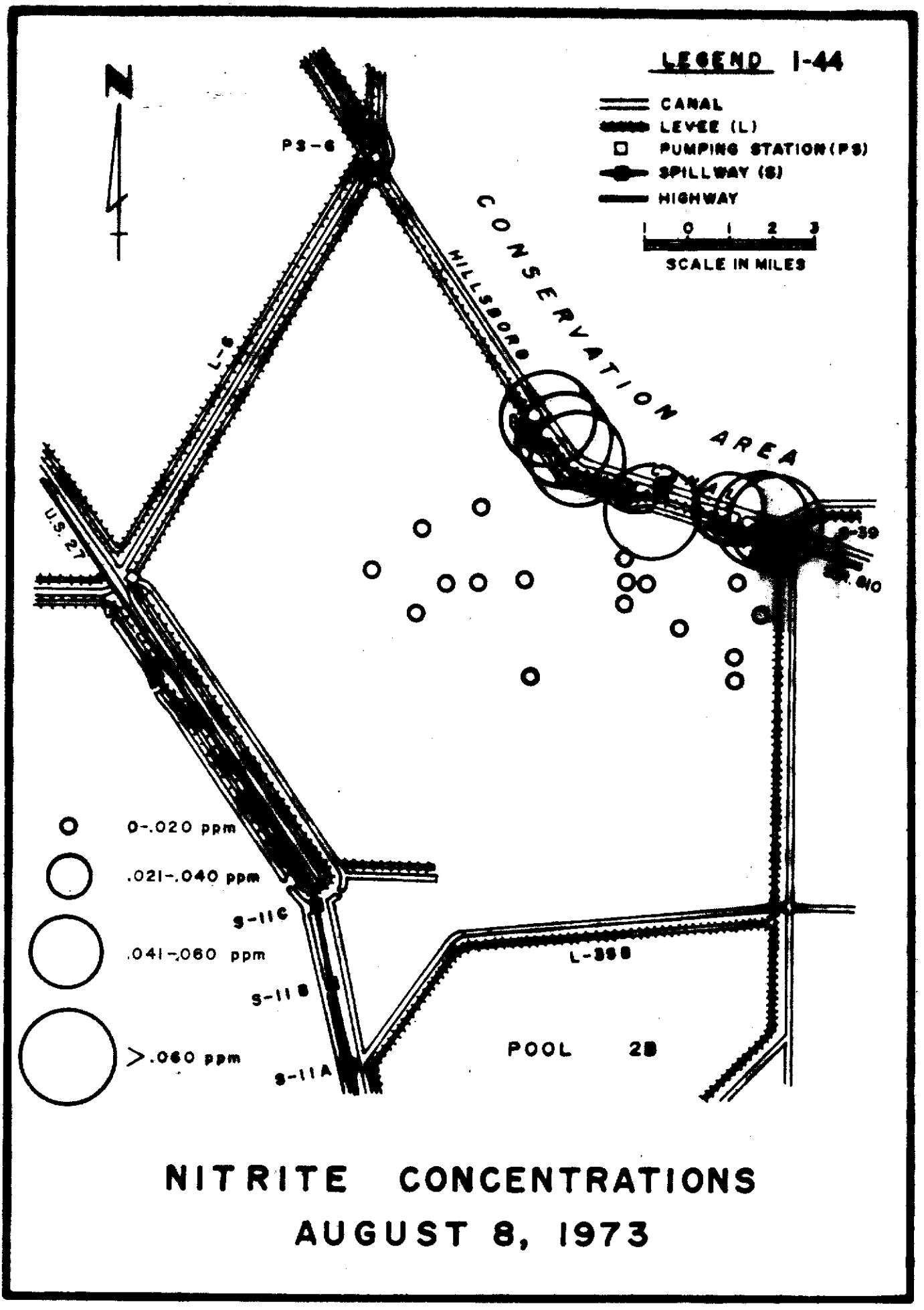
SODIUM CONCENTRATIONS
AUGUST 8, 1973



SILICA CONCENTRATIONS
AUGUST 8, 1973



NITRATE CONCENTRATIONS
AUGUST 8, 1973



NITRITE CONCENTRATIONS
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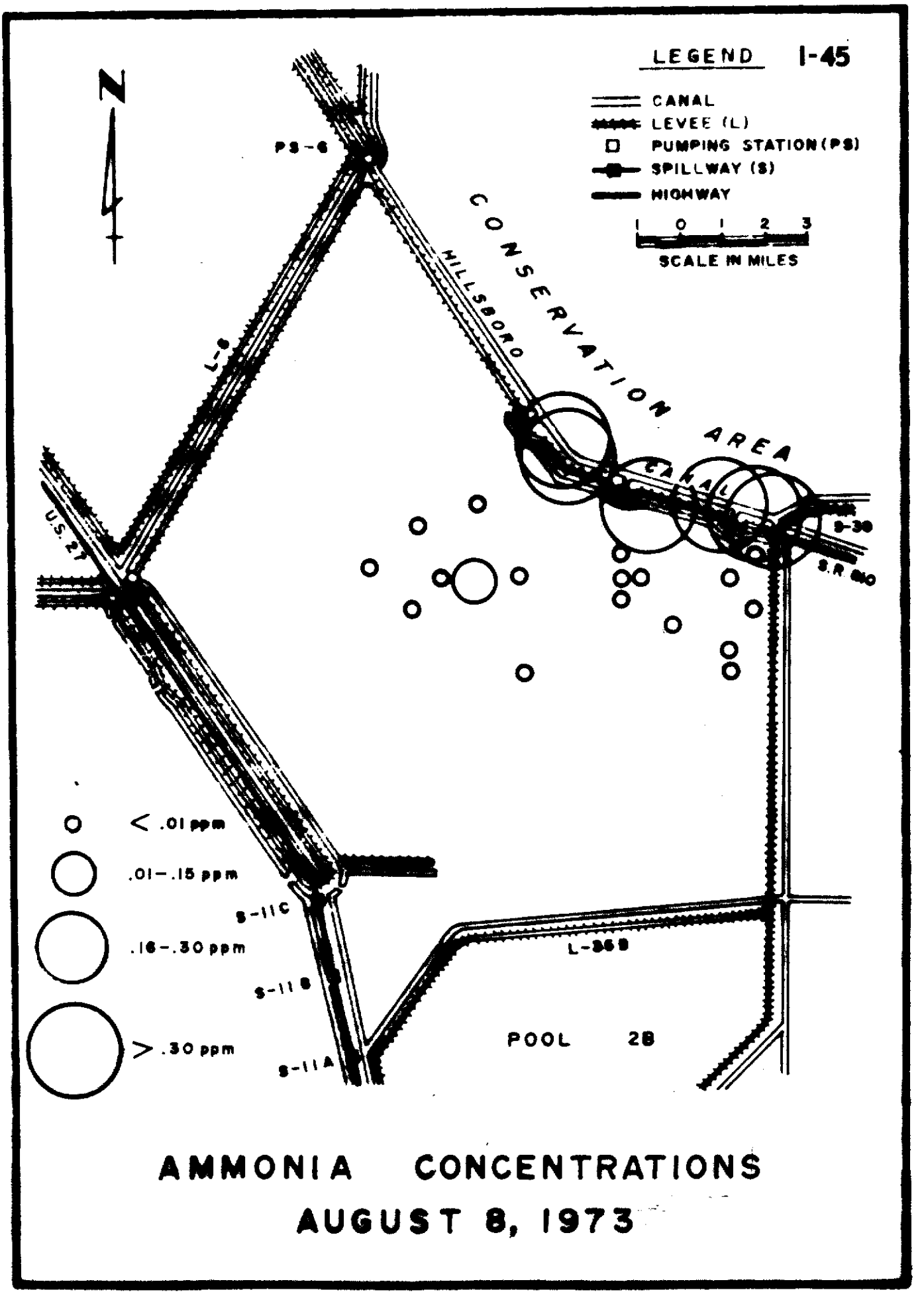
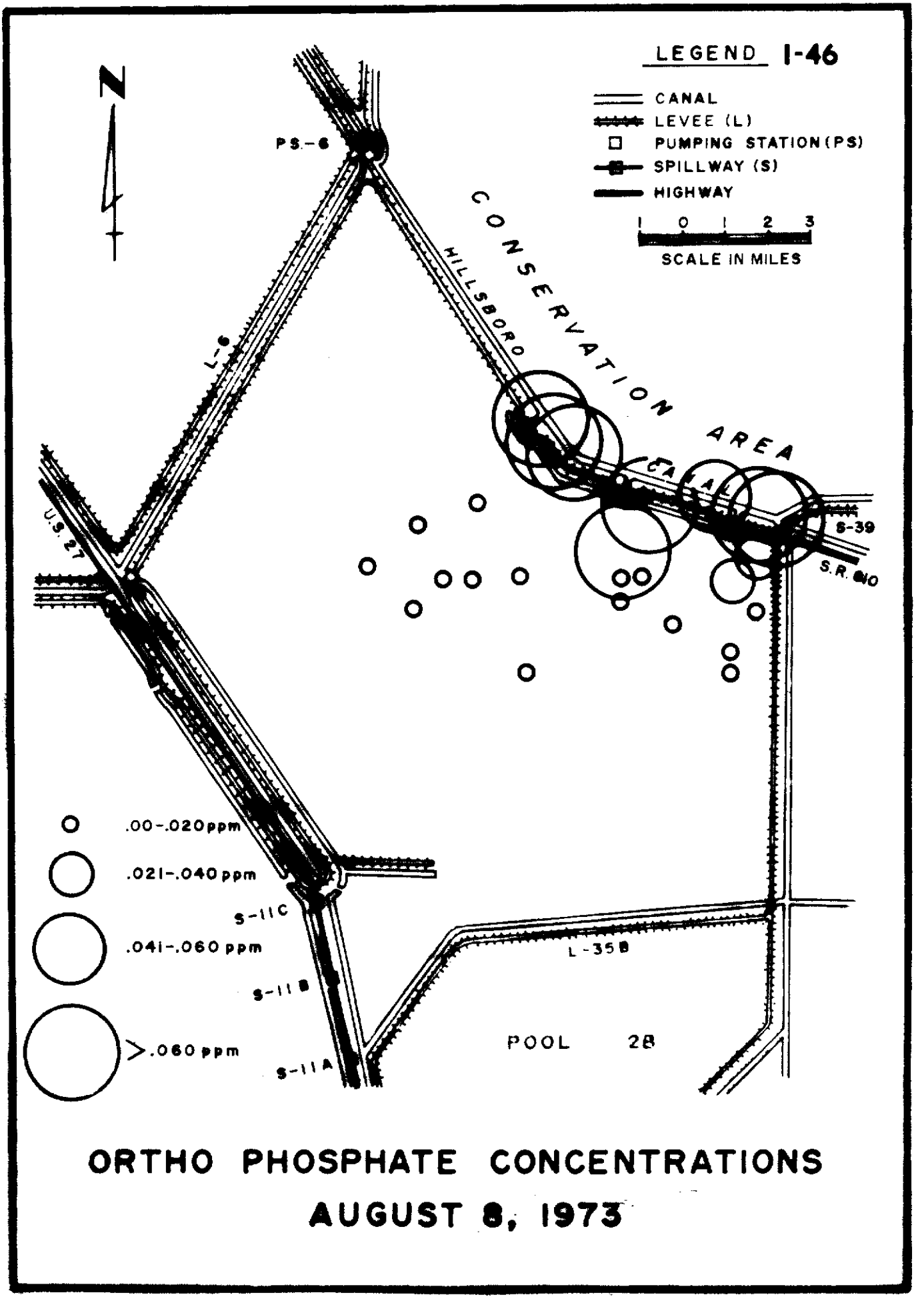
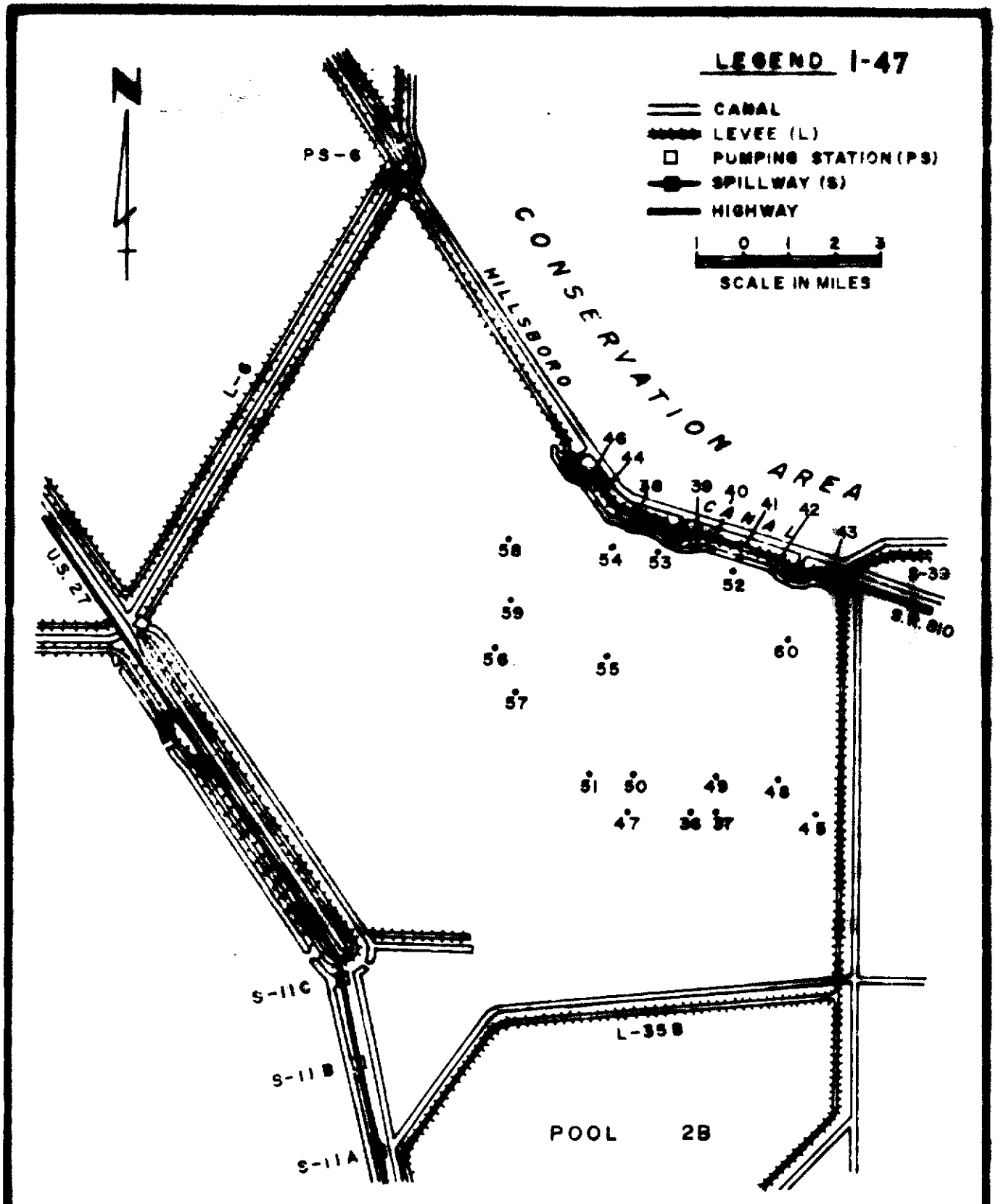


AMMONIA CONCENTRATIONS
AUGUST 8, 1973

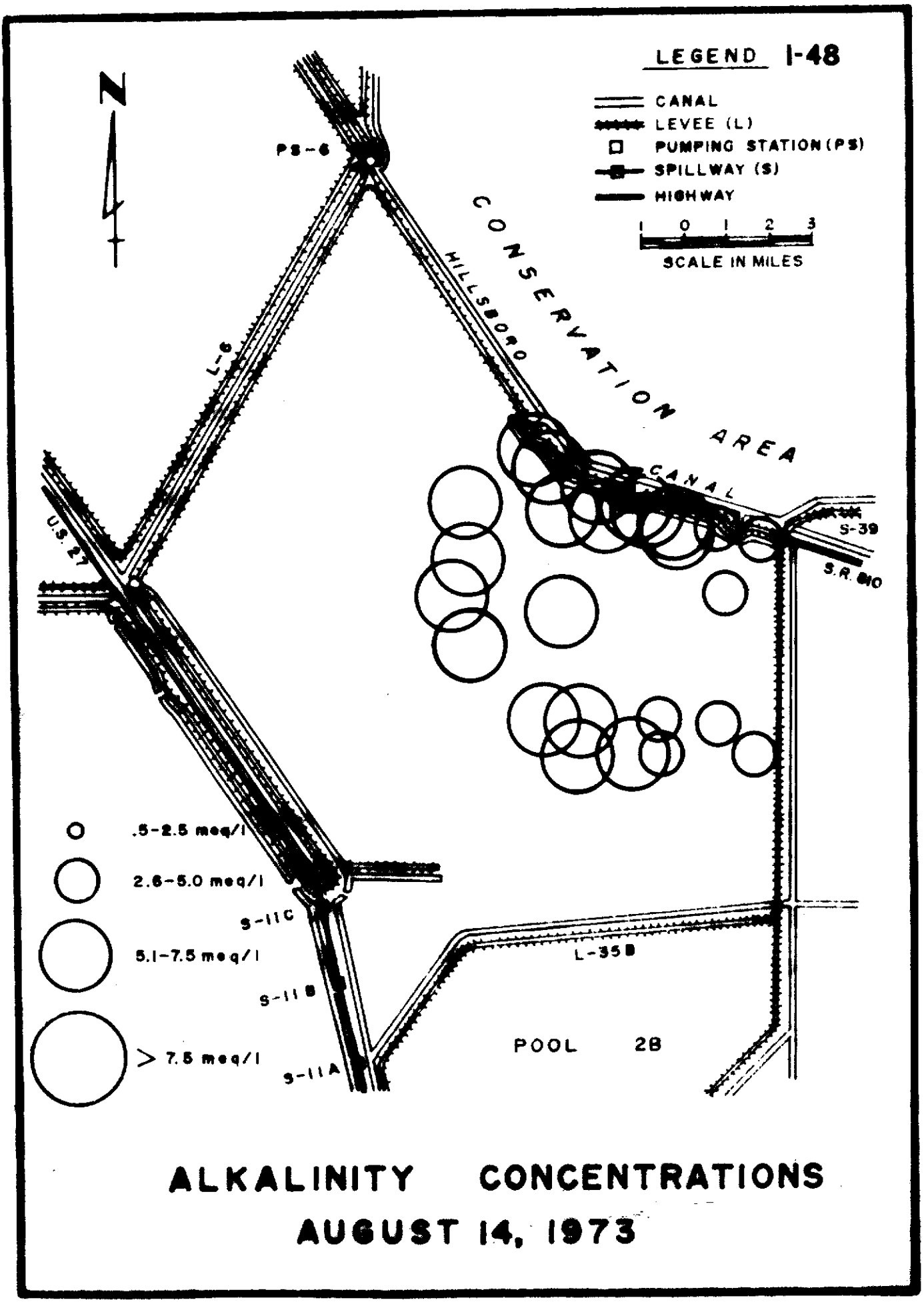


ORTHO PHOSPHATE CONCENTRATIONS

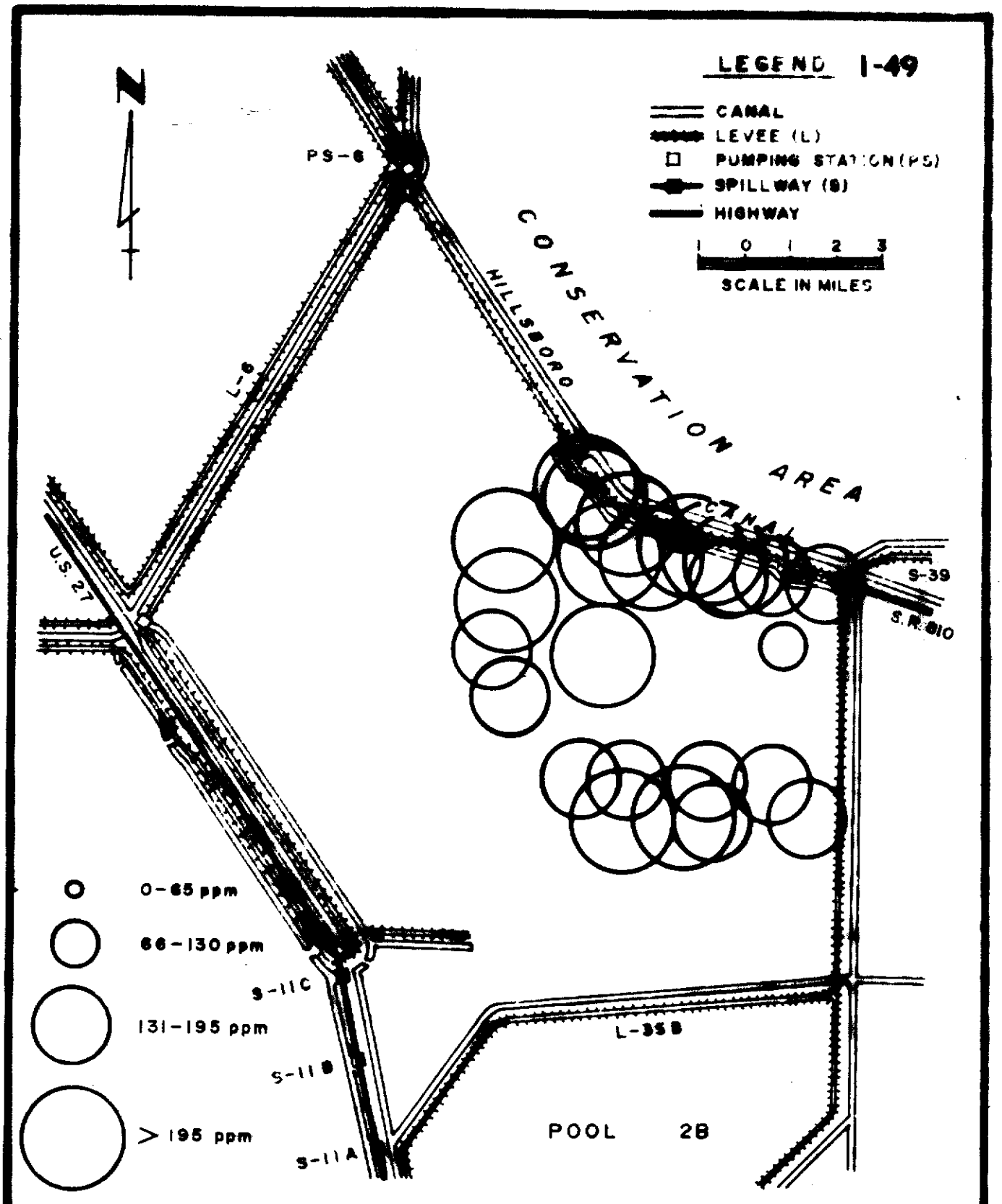
AUGUST 8, 1973



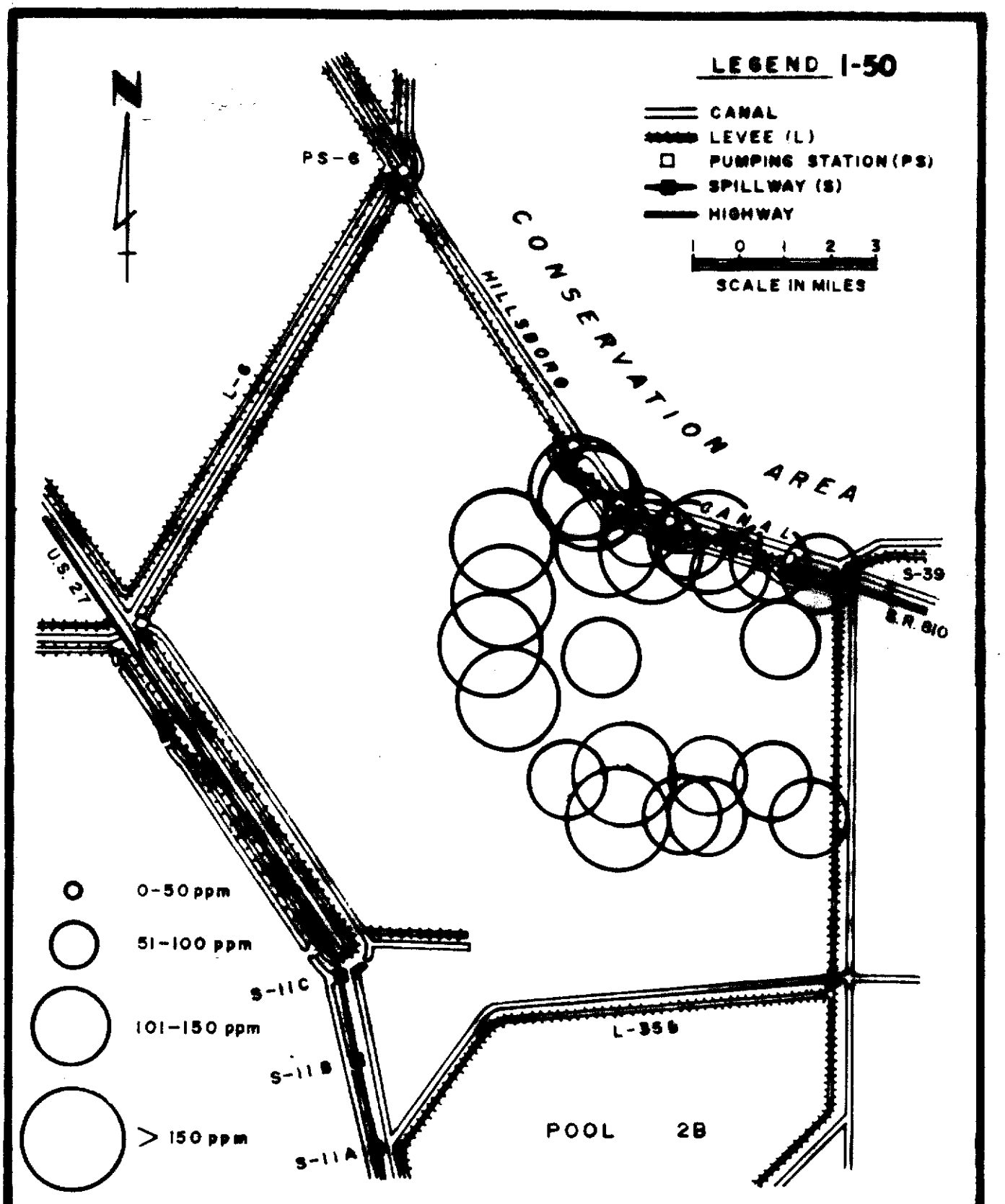
SAMPLING POINTS
AUGUST 14, 1973



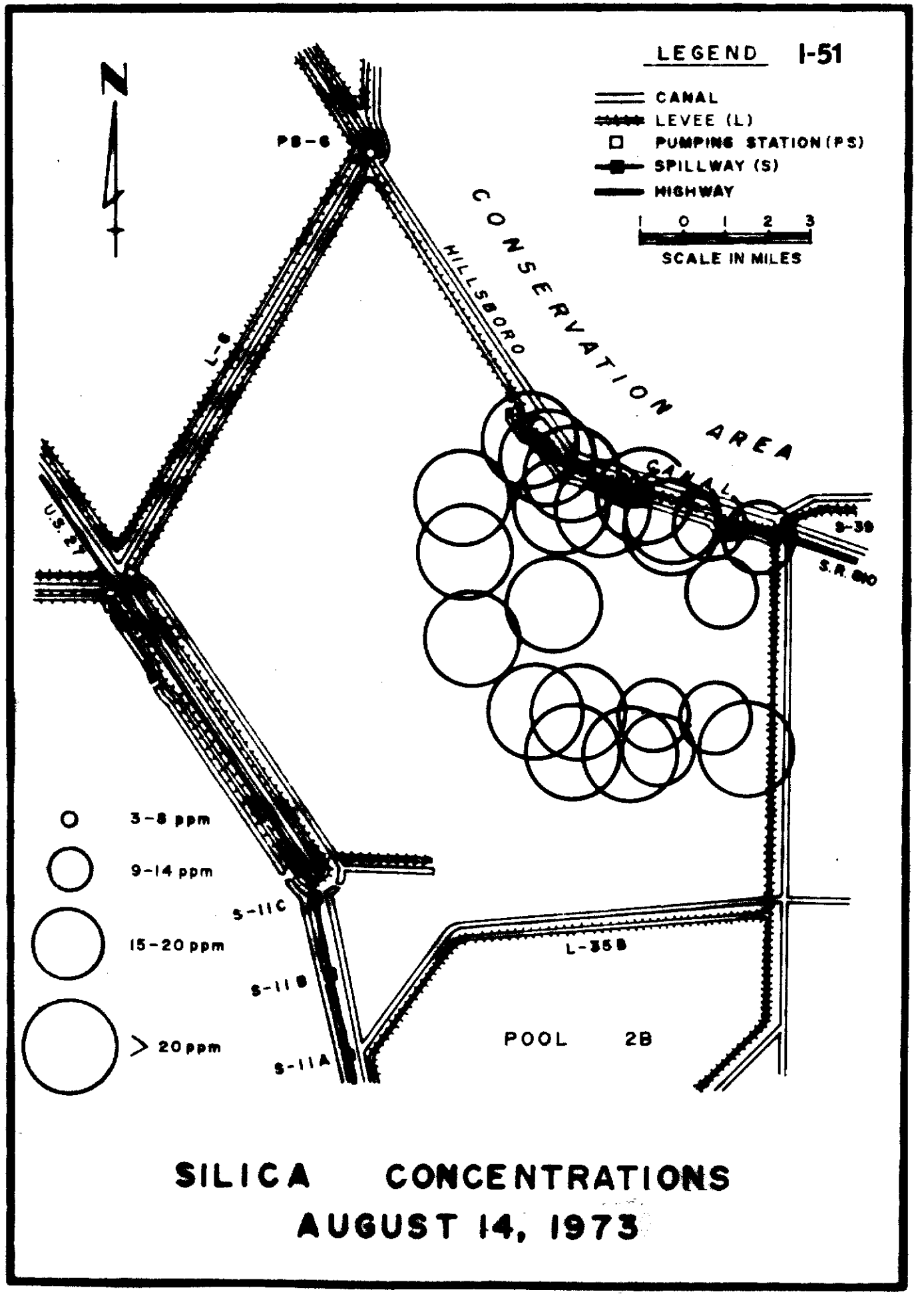
ALKALINITY CONCENTRATIONS
AUGUST 14, 1973



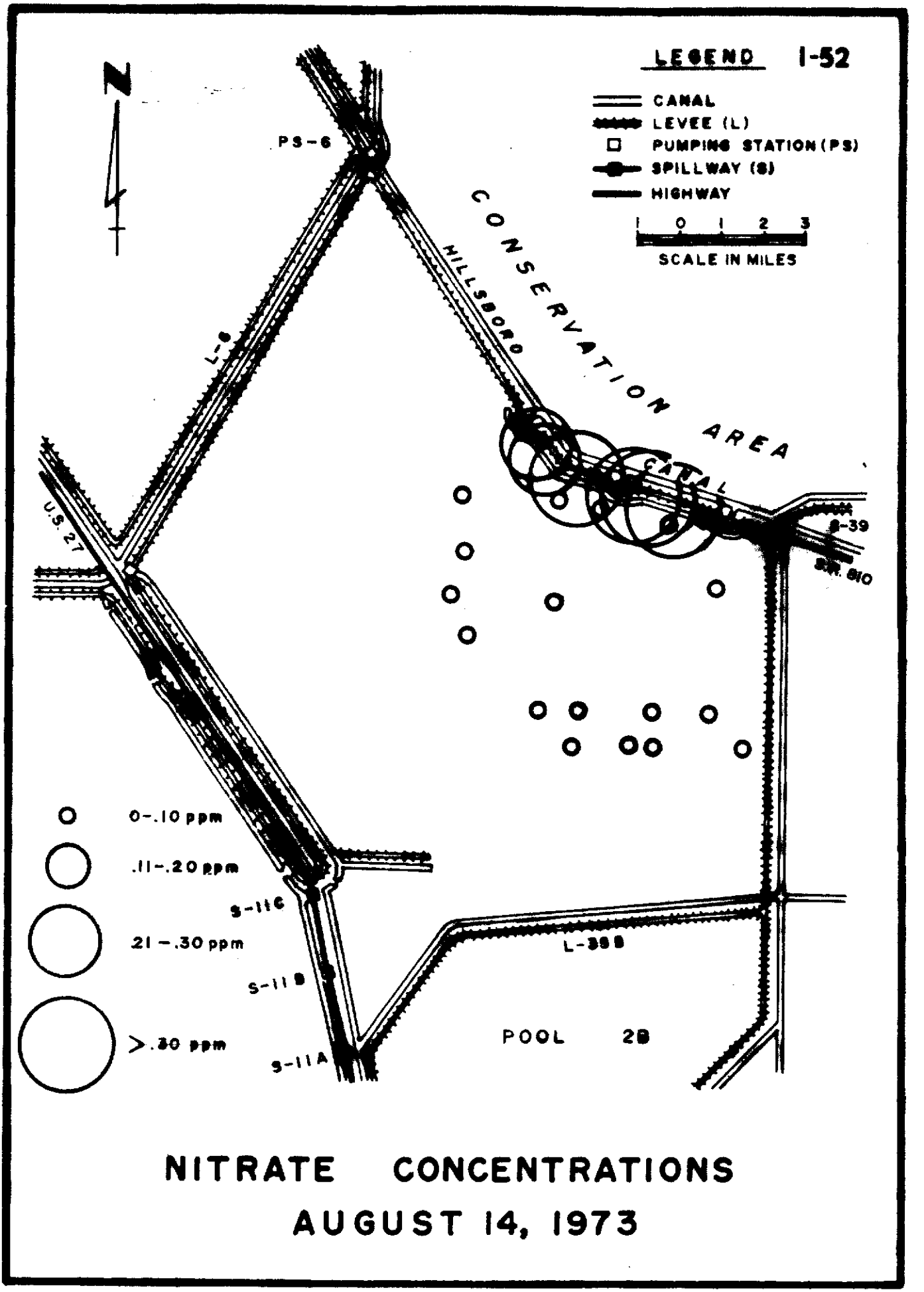
CHLORIDE CONCENTRATIONS
AUGUST 14, 1973



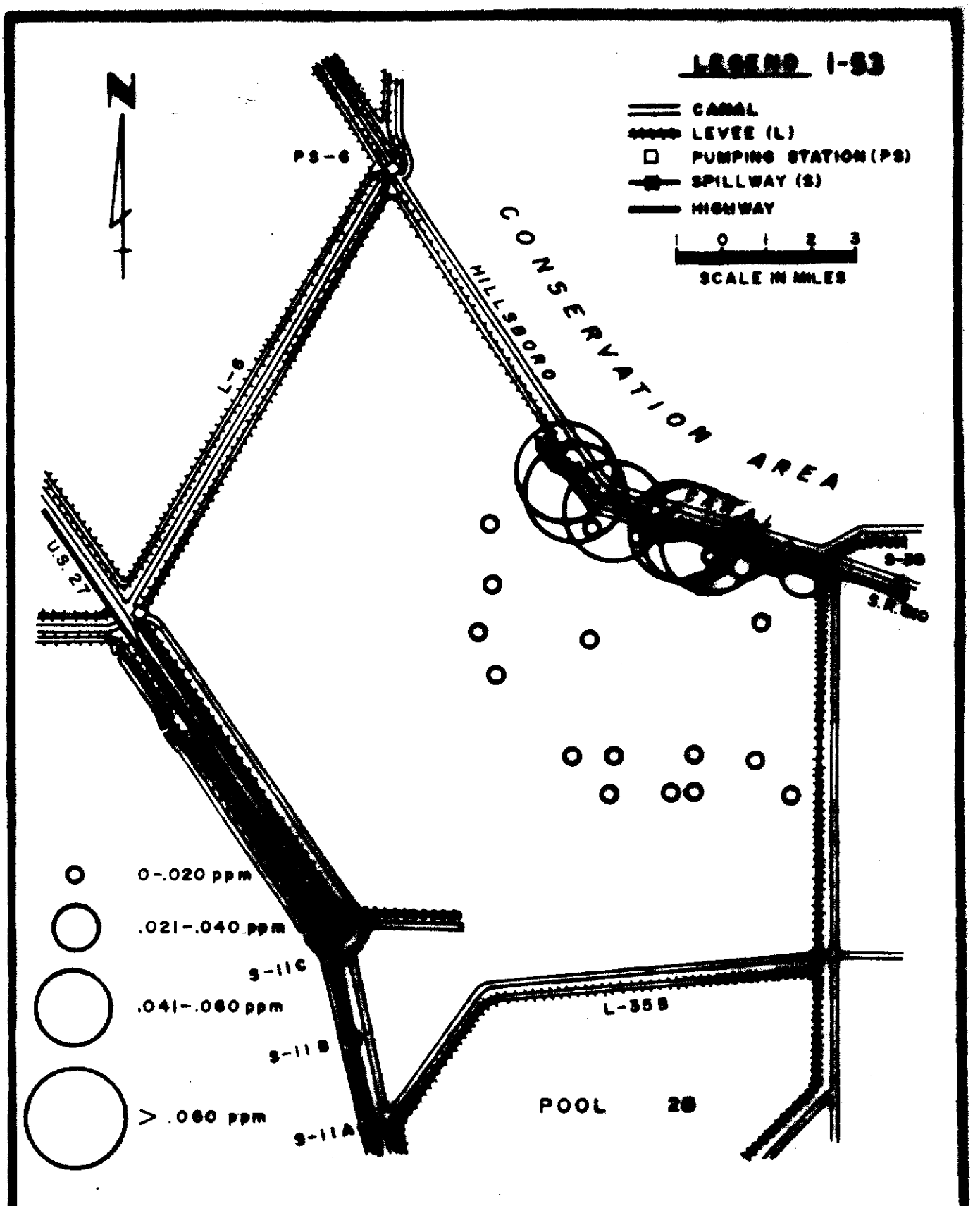
SODIUM CONCENTRATIONS
AUGUST 14, 1973



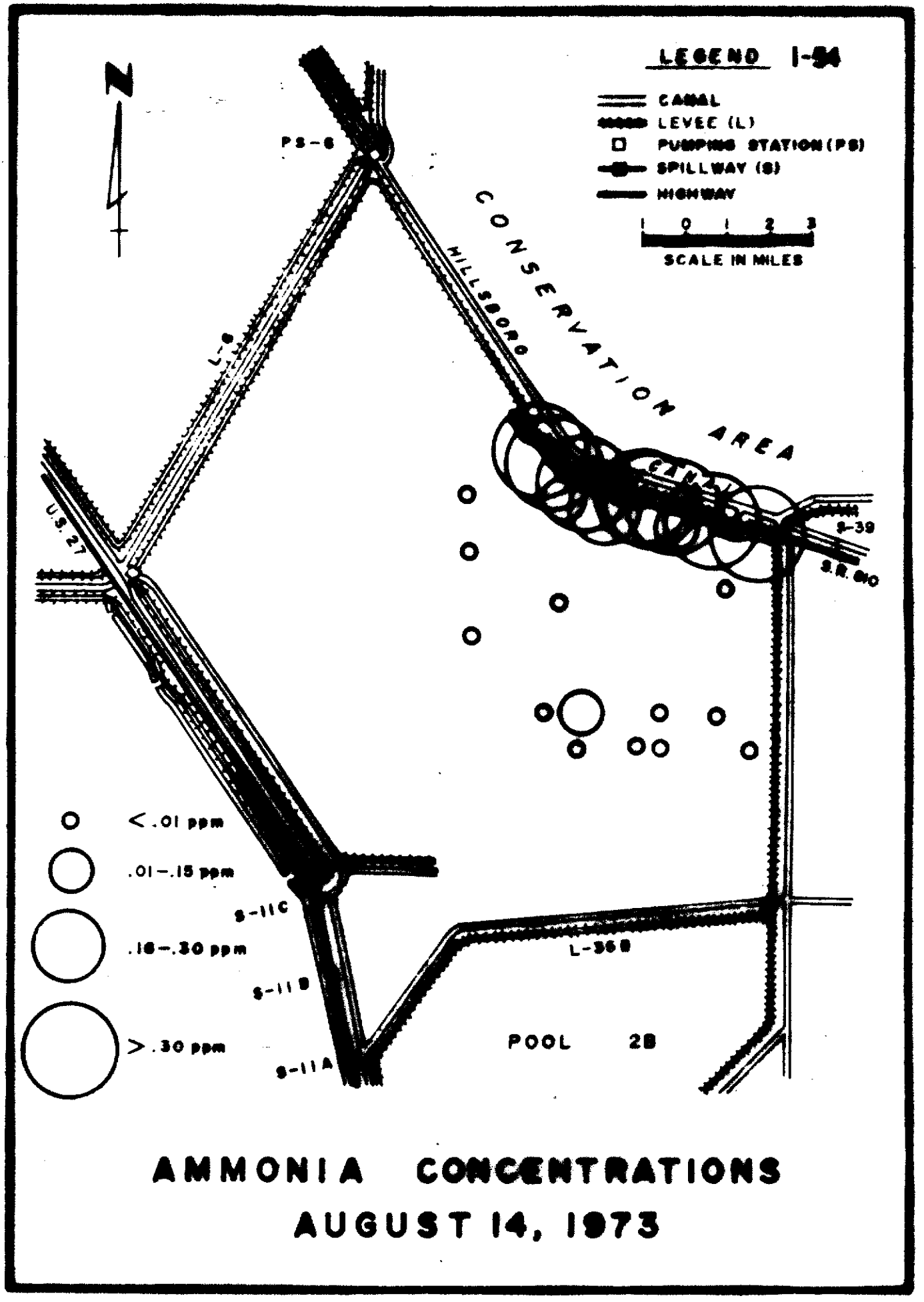
SILICA CONCENTRATIONS
AUGUST 14, 1973



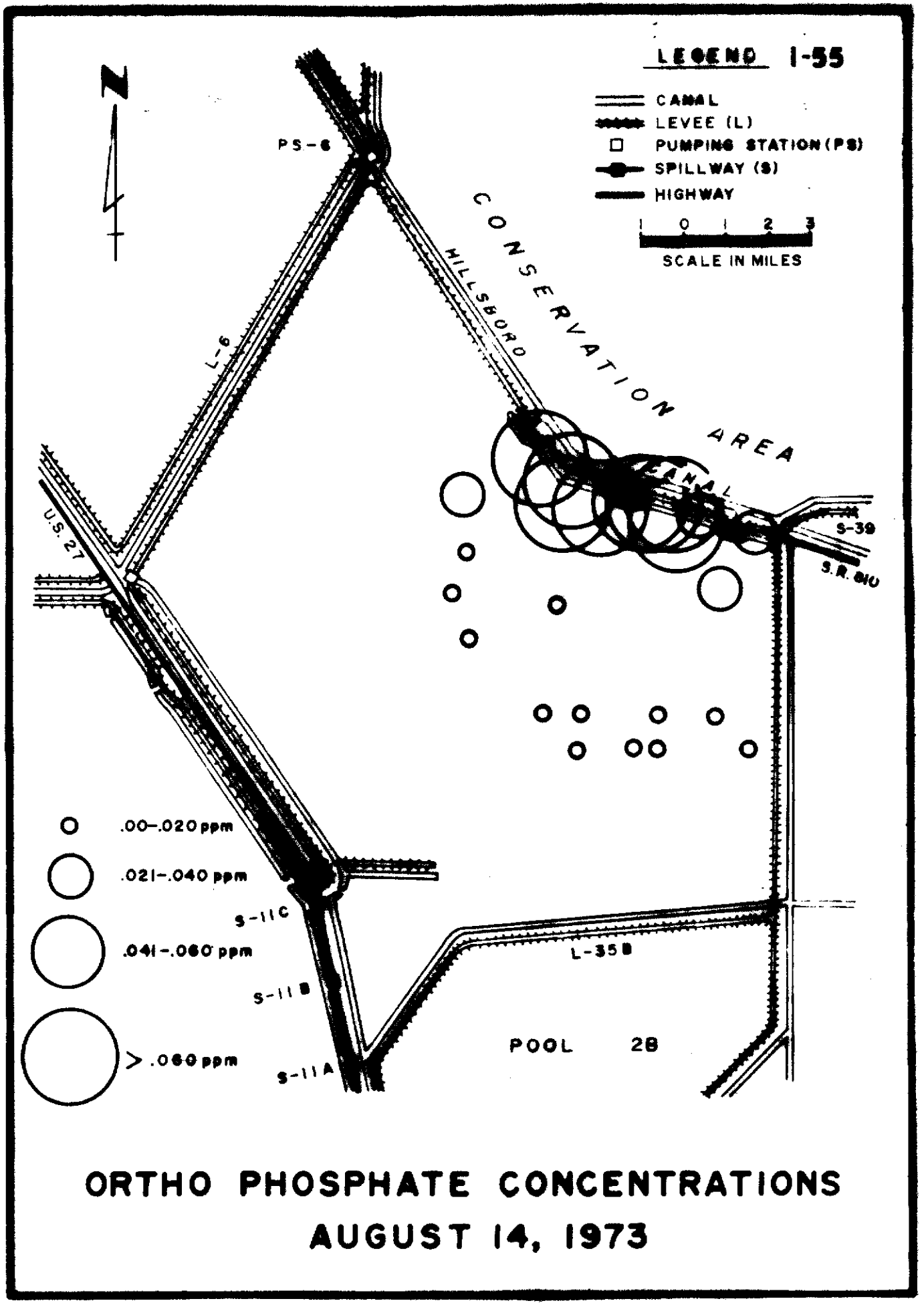
NITRATE CONCENTRATIONS
AUGUST 14, 1973



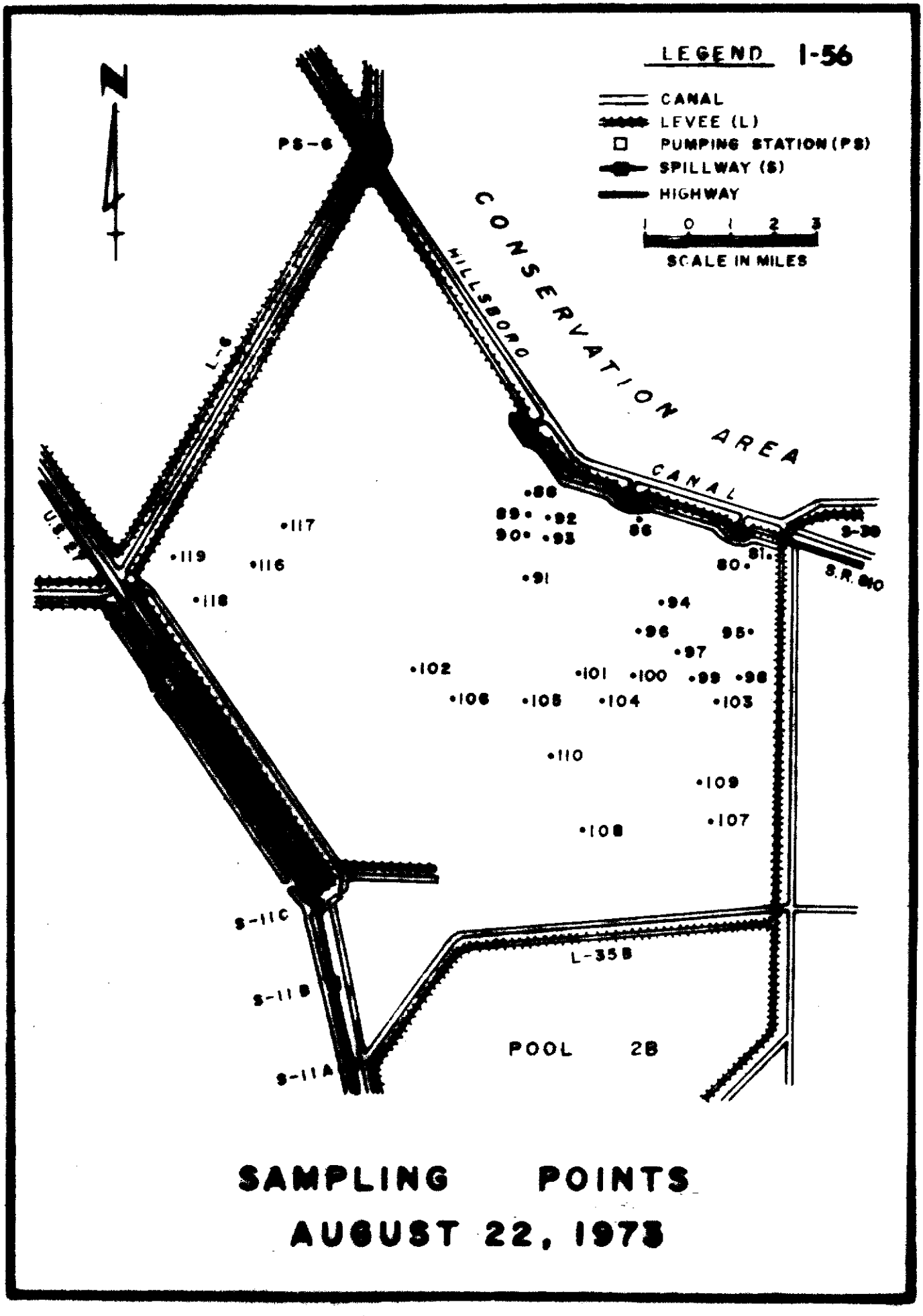
NITRITE CONCENTRATIONS
AUGUST 14, 1973



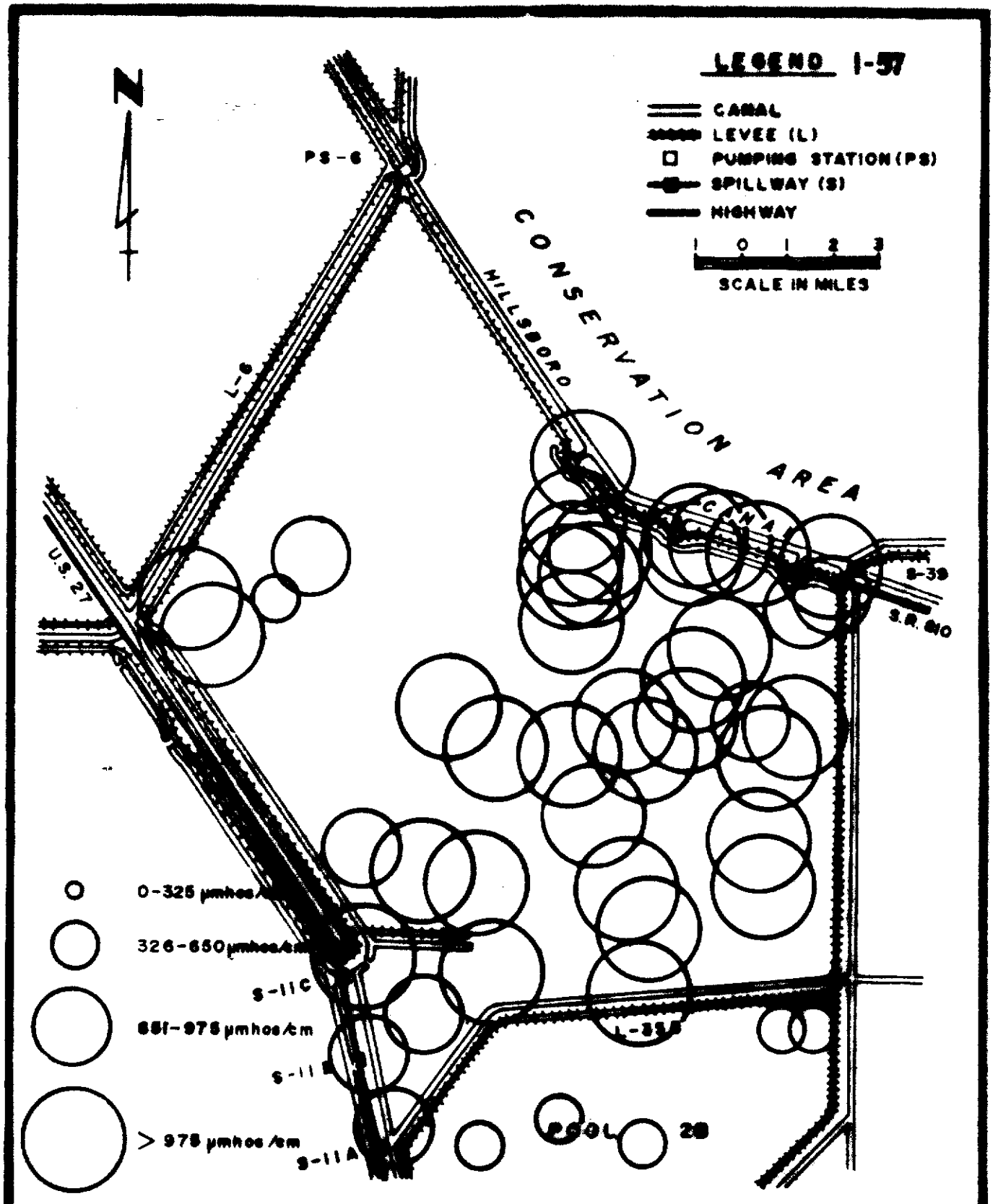
AMMONIA CONCENTRATIONS
AUGUST 14, 1973



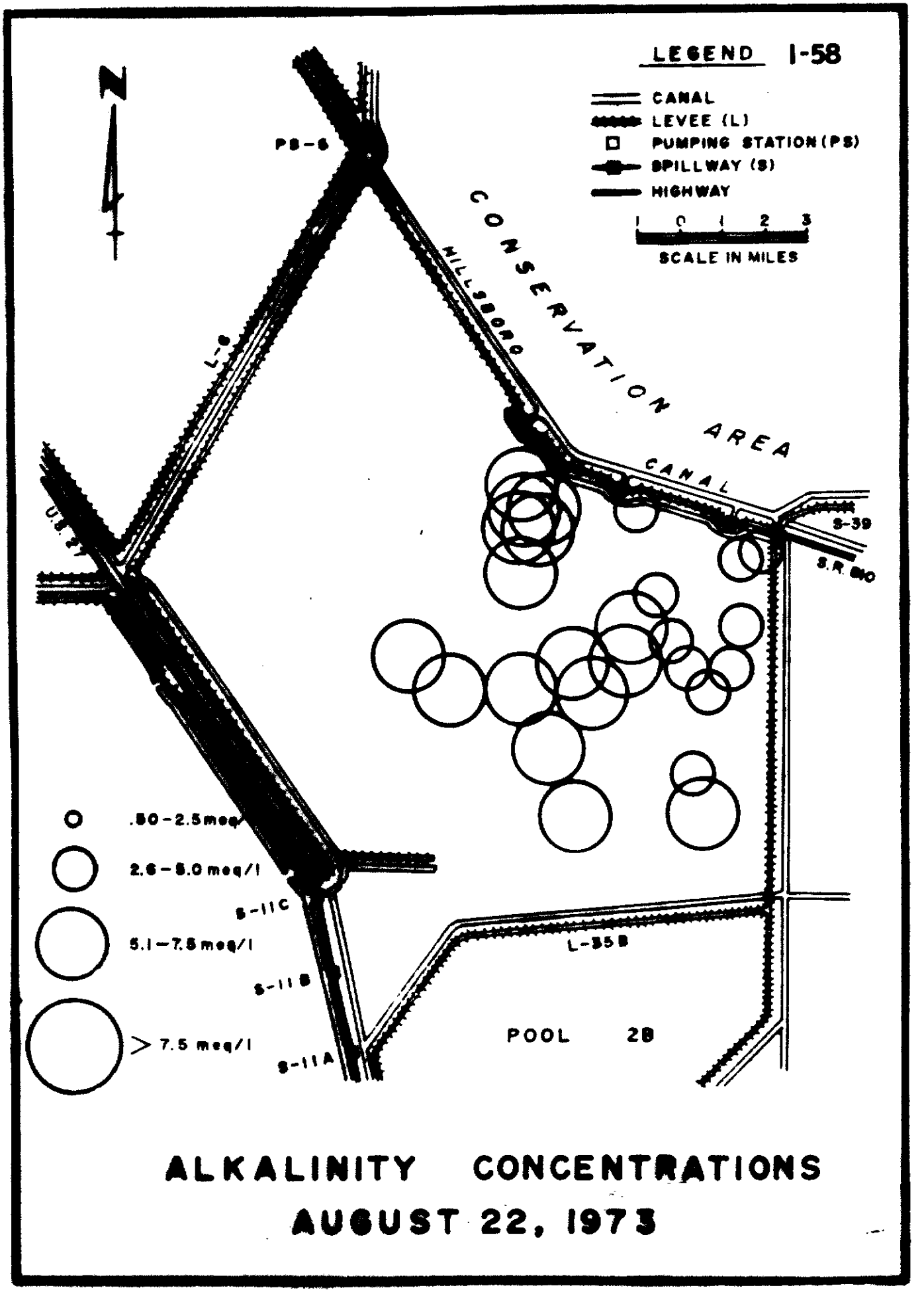
ORTHO PHOSPHATE CONCENTRATIONS
AUGUST 14, 1973



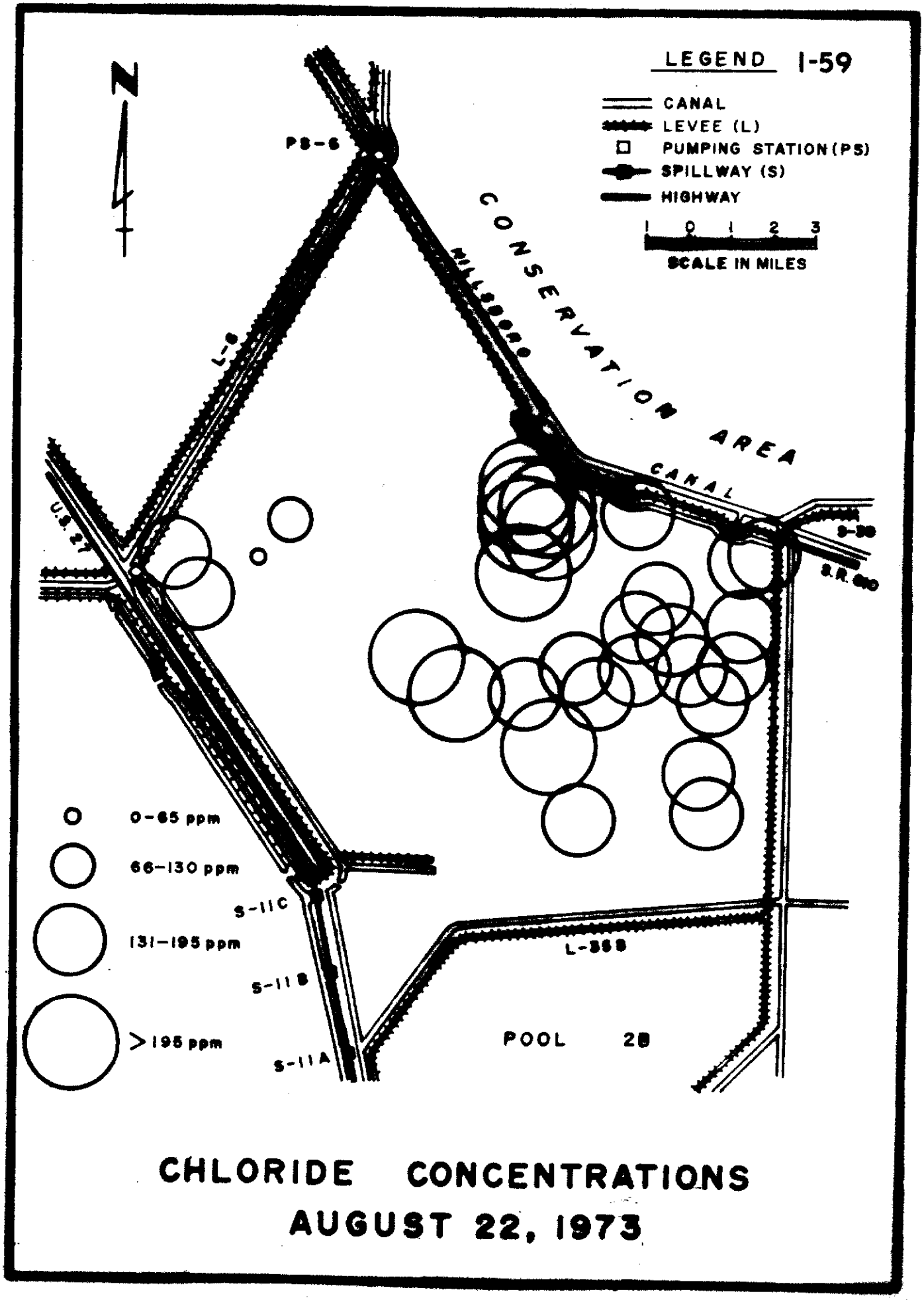
SAMPLING POINTS
AUGUST 22, 1973



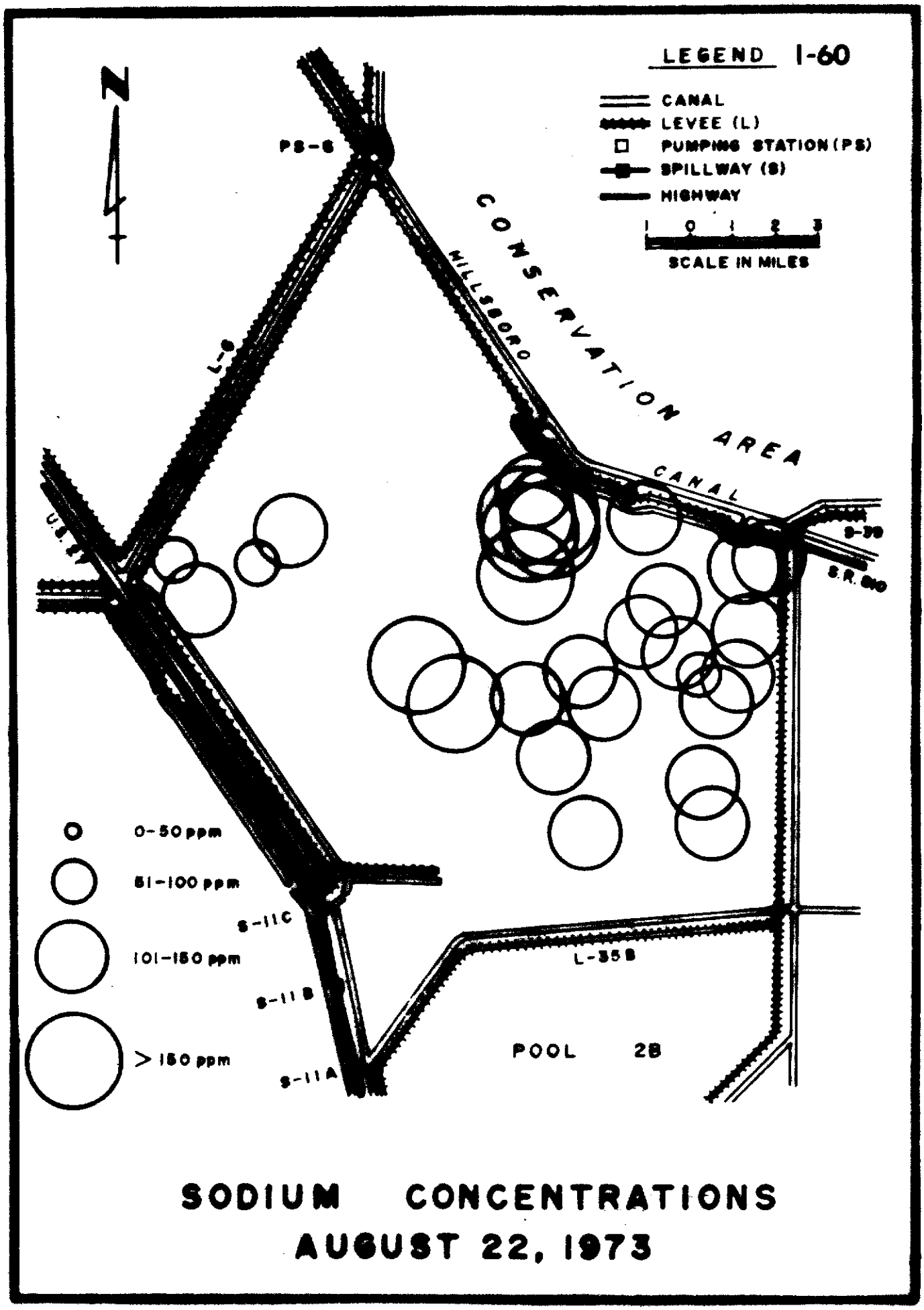
CONDUCTIVITY
AUGUST 22, 1973



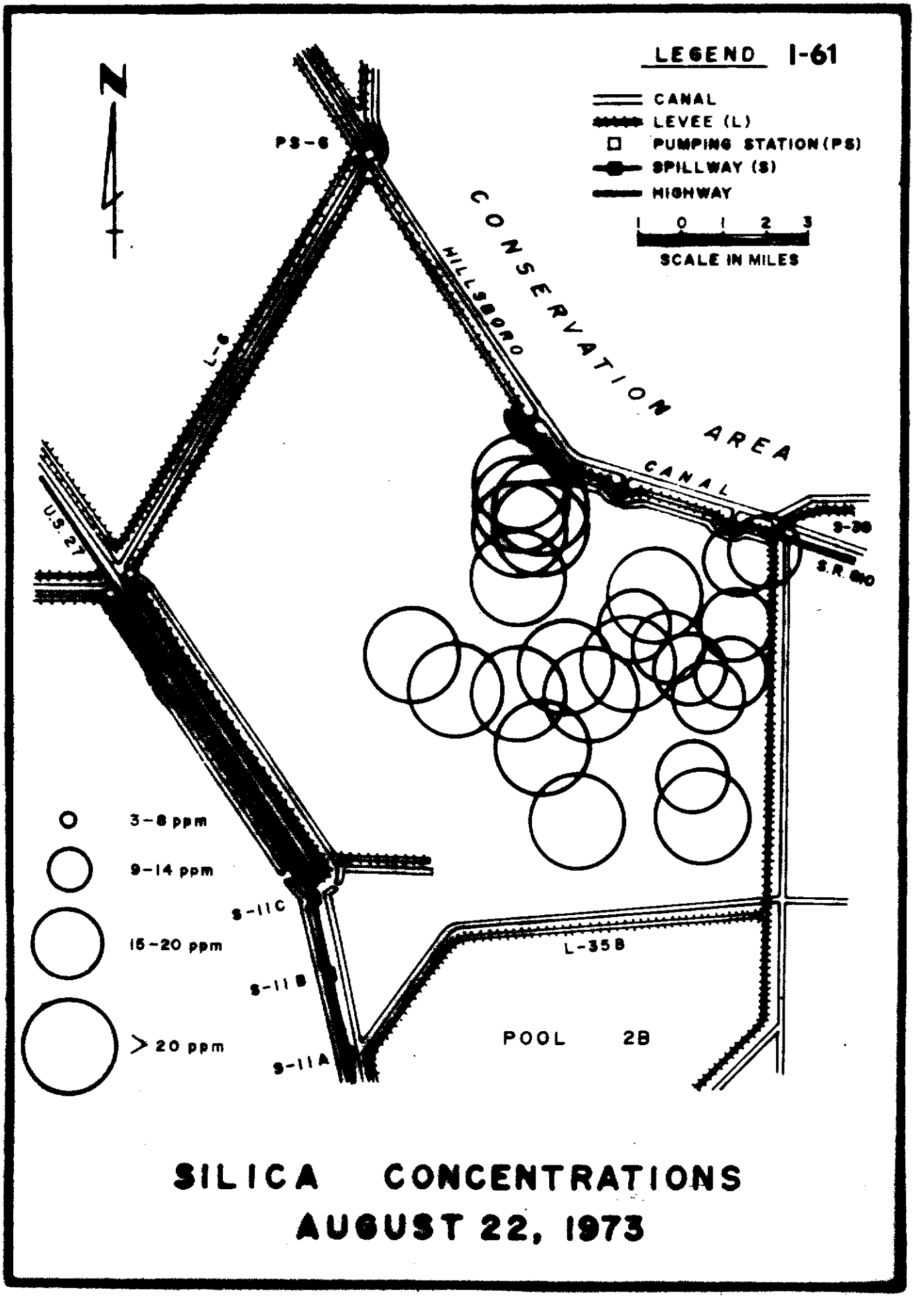
ALKALINITY CONCENTRATIONS
AUGUST 22, 1973



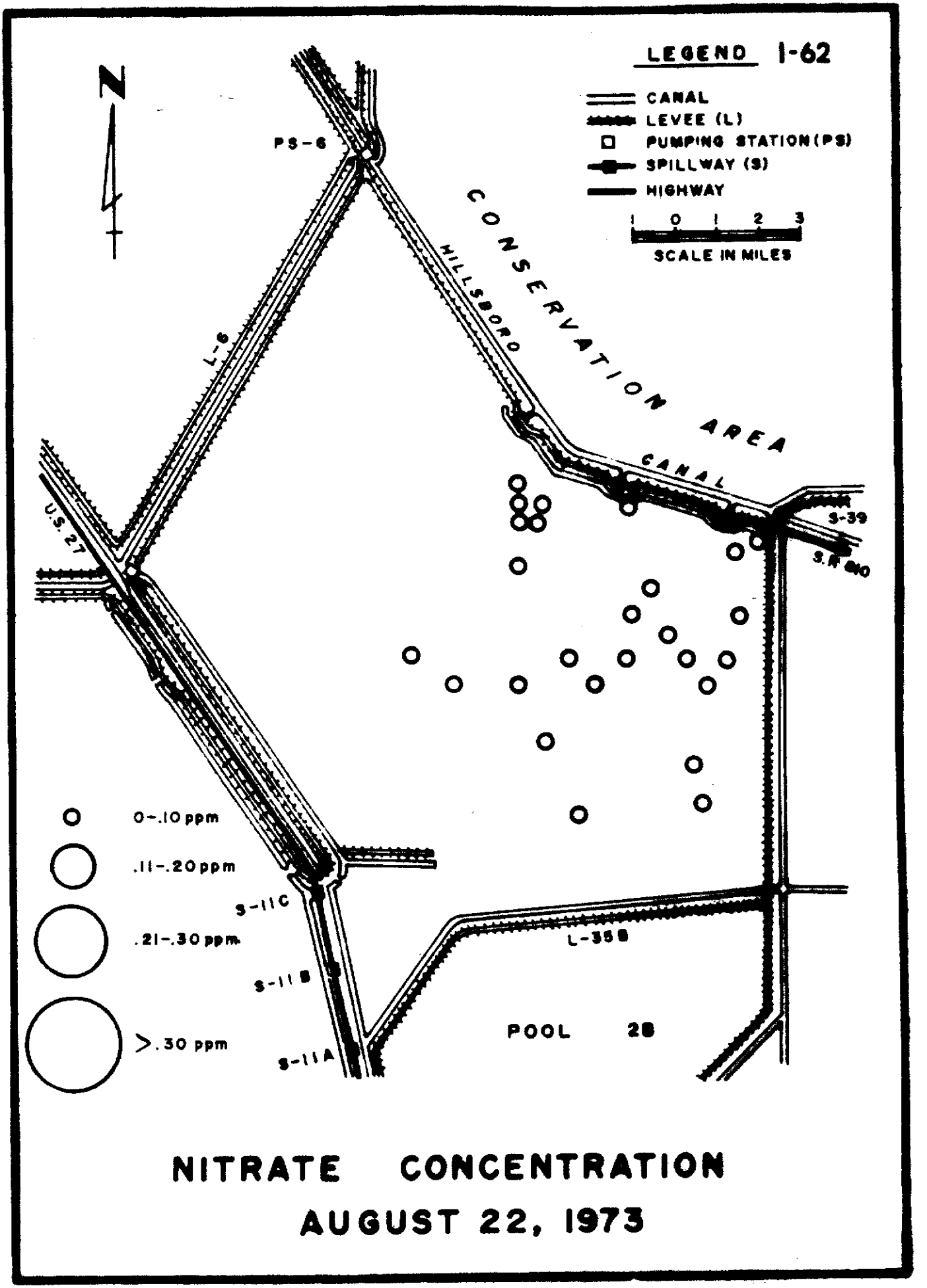
CHLORIDE CONCENTRATIONS
AUGUST 22, 1973



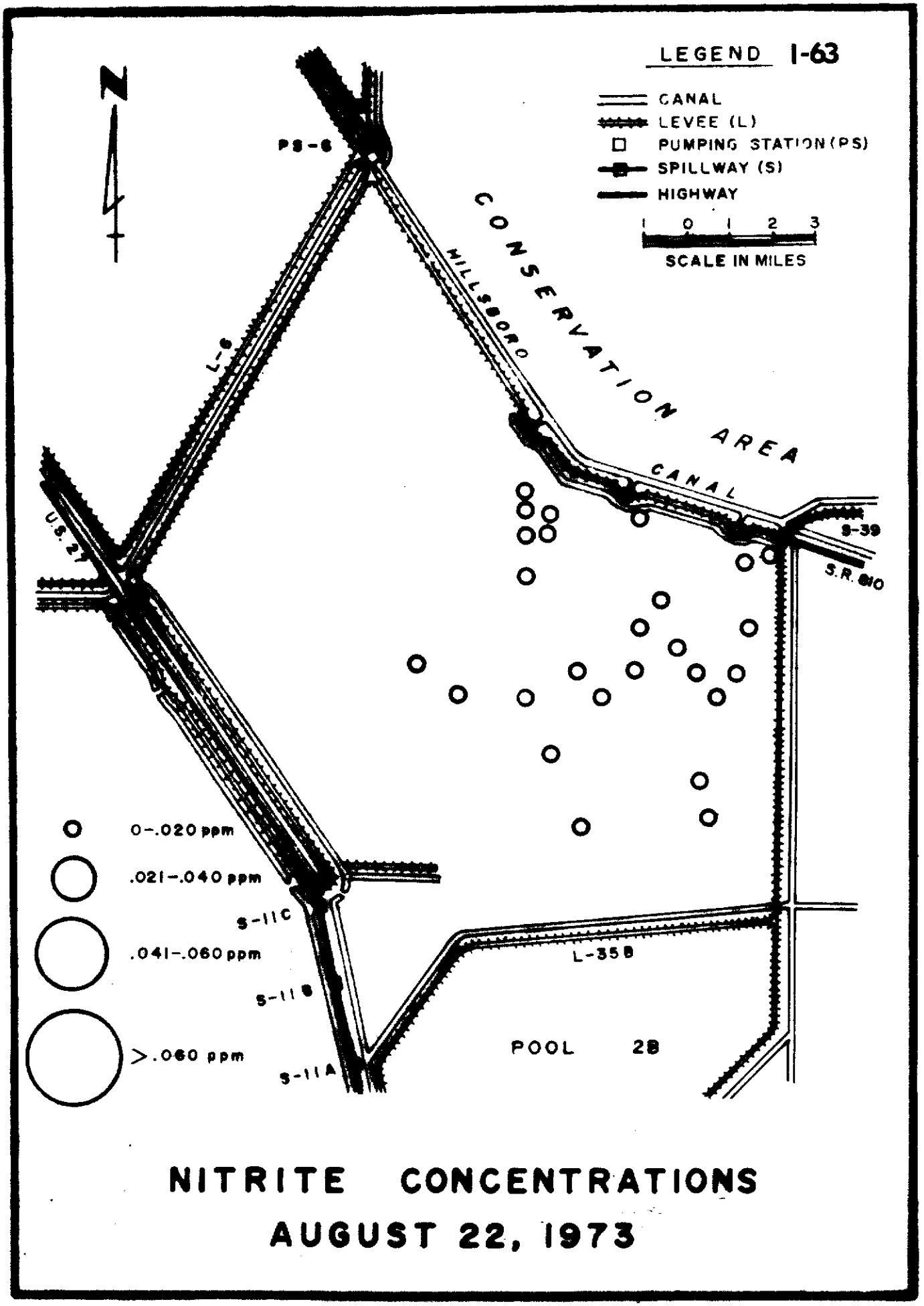
SODIUM CONCENTRATIONS
AUGUST 22, 1973



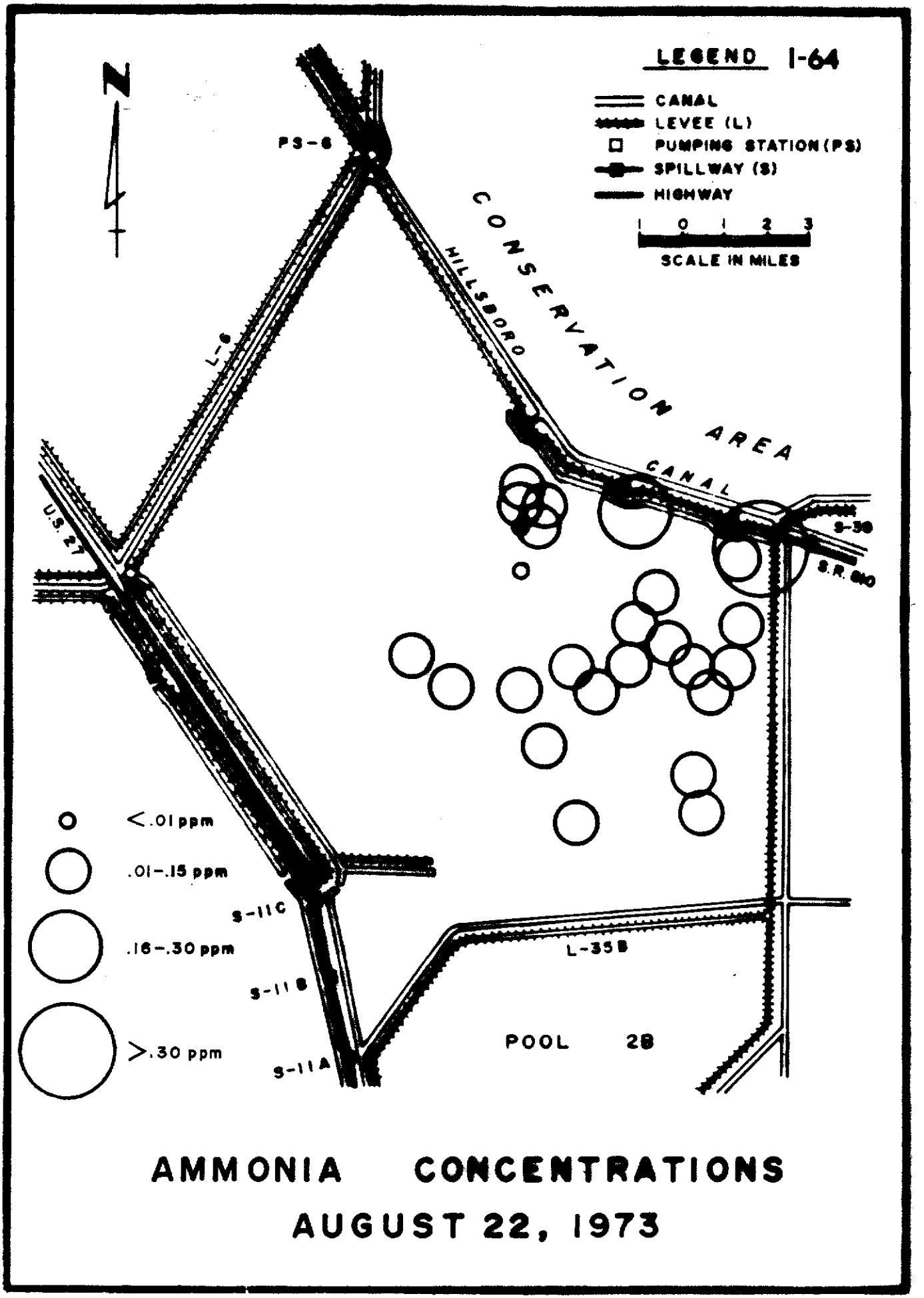
SILICA CONCENTRATIONS
AUGUST 22, 1973



NITRATE CONCENTRATION
AUGUST 22, 1973

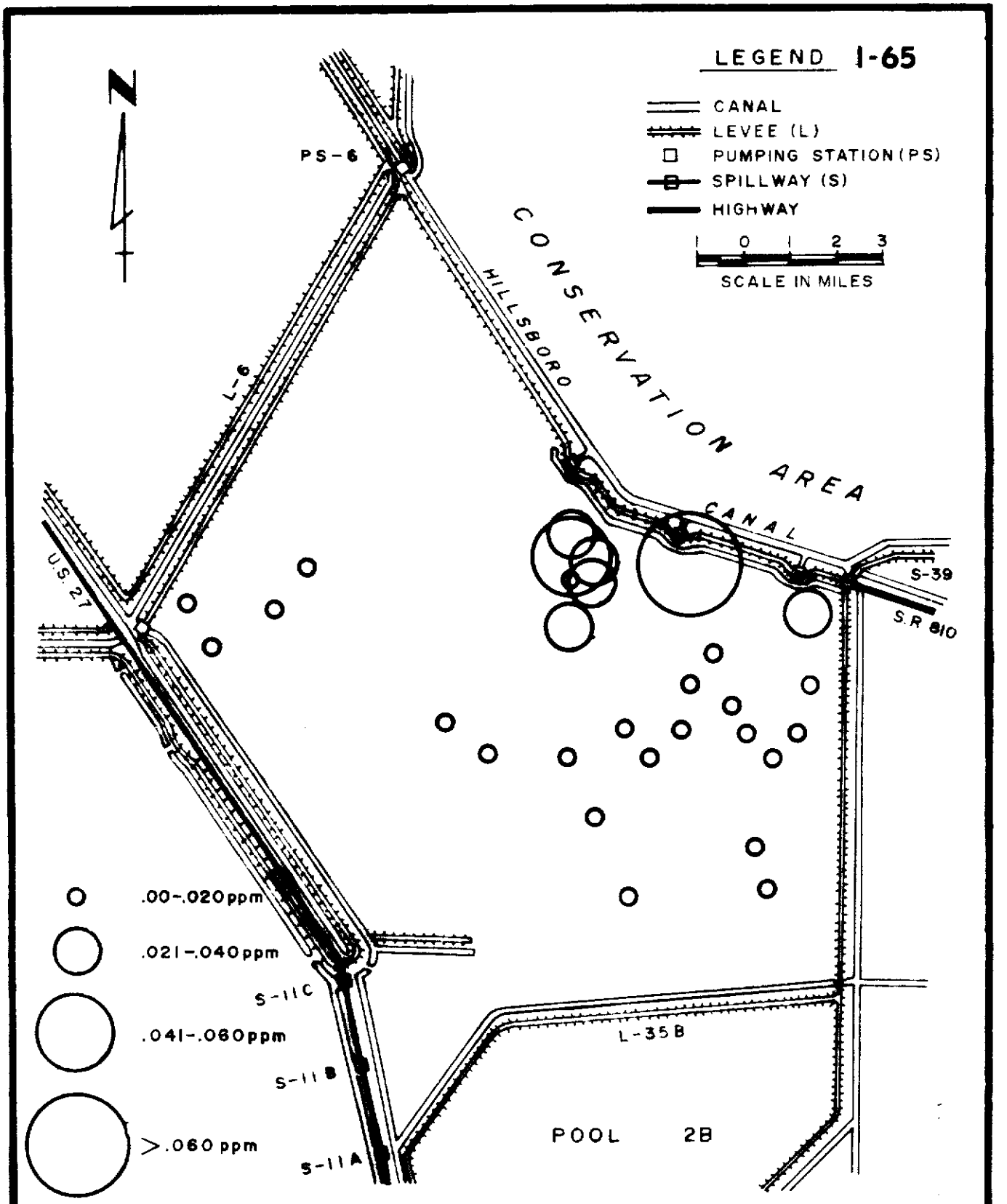


NITRITE CONCENTRATIONS
AUGUST 22, 1973



AMMONIA CONCENTRATIONS

AUGUST 22, 1973



ORTHO PHOSPHATE CONCENTRATIONS
AUGUST 22, 1973

APPENDIX II

TABULATED CHEMICAL DATA

CHEMICAL COMPOSITION OF WATER COLLECTED IN
CA-2A MARSH - OCTOBER 11, 1972

Sample No.	SiO_2	Cl
A1	33.2	243
A2	13.8	121
A3	0.5	44
B1	2.8	61
B2	3.7	58
B3	10.2	112
B4	21.9	153
B5	23.9	179
C1	21.6	166
C2	21.8	131
C3	26.6	179
C4	23.7	182
C5	20.6	131
C6	11.0	105
C7	12.2	112
C8	8.8	74
D1	17.9	152
D2	11.6	121
D3	16.7	118
D4	21.6	114
D5	28.9	169
D6	24.4	131
D7	21.6	115
D8	9.2	72
D9	6.2	96
E1	8.7	80
E2	18.7	81
E3	21.9	110
E4	26.8	123
E5	24.8	121
E6	20.6	141
E7	19.2	152
G1	14.8	86
G2	15.4	72
G3	23.1	115
G4	21.6	113
G5	25.1	118
G6	22.5	137
H1	22.8	139
H2	25.3	118
H3	16.9	82
I	21.6	134
J1	18.4	122
J2	19.3	106
J3	9.7	75
J4	8.9	63
J5	7.6	57
J6	7.0	47
J7	7.9	53

CHEMICAL COMPOSITION OF WATER IN CA-2A MARSH -- NOVEMBER 11, 1972, FEBRUARY 13, 1973, JUNE 26, 1973

Analyses in PPM-ALK in Meq/l

Date	Sample	NO_3-N	NO_2-N	NH_3-N	O-PO_4-P	DisOrgPO4-P	Cl	Na	SiO_2	Sp. Cond.
11/16/72	C1	<.002	<.004	<.4	<.004		180		23	
11/16/72	C2	<.002	<.004	<.4	<.004		134		21	
11/16/72	C3	<.002	<.004	<.4	<.004		155		22	
11/16/72	C4	<.002	<.004	<.4	<.004					
11/16/72	C5	<.002	<.004	<.4	<.004		175		20	
11/16/72	C6	<.002	<.004	<.4	<.004		131		17	
2/13/73	C1	.13	.006	.05	<.001	<.007	314	215	16	
2/13/73	C2		.004	.04	<.001	<.011	400	223		
2/13/73	C3				.006			169		
2/13/73	C4	.001	.003	.03	<.001		202	138	4.6	
2/13/73	C5	<.010	<.001	.07	<.001	<.009	146	101	7.0	
2/13/73	C6	<.002	<.001	.04	<.001	<.005	145	93	6.0	
2/13/73	D1	<.004	<.001	.03	<.001	<.003	144	102	10.0	
2/13/73	D2	<.031	<.001	.04	<.001	<.002	135	95	5.9	
2/13/73	D3	<.001	<.001	.02	<.001	<.002	148	102	7.7	
2/13/73	D4	<.019	<.001	.08	<.001	<.002	190	127	11	
2/13/73	D5	<.008	<.001	.09	<.001	<.002	228	159	13	
2/13/73	D6	<.059	<.001	.11	<.001	<.002	162	114	15	
2/13/73	D7	<.006	<.001	.04	<.001	<.002	136	94	6.7	
2/13/73	D8	<.003	<.001	.03	<.001	<.004	210	137	6.0	
2/13/73	E1	<.003	<.001	.03	<.001	<.002	141	97	6.6	
2/13/73	E2	<.001	<.001	.03	<.001	<.005	136	91	12	
2/13/73	E3	<.018	<.001	.07	<.001	<.002	234	156	16	
2/13/73	E4	<.012	<.001	.05	<.001	<.002	151	107	9.6	
2/13/73	E5	<.059	<.001	.06	<.001	<.002	127	84	6.4	
2/13/73	F1	<.006	<.001	.06	<.001	<.002	147	115	18	
2/13/73	F2	<.011	<.001	.04	<.001	<.002	159	115	18	
2/13/73	F3	<.052	<.001	.39	.003	.000	118	91	18	
2/13/73	F4	<.009	<.001	.07	<.001	<.002	109	79	11	
2/13/73	F5	<.001	<.001	.02	<.001	<.002	95	65	7.6	
2/13/73	F6	<.005	<.001	.03	<.001	<.002	89	61	1.2	
2/13/73	S146	<.014	<.001	.06	<.001	<.002	80	53	5.2	
2/13/73	S145	<.013	<.001	.05	<.001	<.003	84	63	7.5	
2/13/73	S144	<.013	<.001	.04	<.001	<.002	91	69	9.8	
2/13/73	G1	<.001	<.001	.03	.003	.000	138	95	18	
2/13/73	S11A	<.001	<.001	.06	<.001	<.002	123	90	14	
2/13/73	S11B	<.012	<.001	.07	<.001	<.002	113	80	14	
2/13/73	S11C	<.011	<.001	.13	<.001	<.002	145	101	13	
6/26/73	C1	.000	.06	.07			252	195	27	1200
6/26/73	C2	<.008	<.004	.08	.04		529	419	19	2100
6/26/73	C3	<.008	<.008	.12	<.001		376	261	30	1575
6/26/73	C5	<.008	<.004	.08	.01		404	299	49	1750
6/26/73	C6	<.008	<.004	.19			341	266	37	1500
6/26/73	C7	<.008	<.004		<.001		168	126	30	700
6/26/73	E5	<.008	<.004	.13	<.001		577	349	40	1650
6/26/73	E4	<.008	<.004	.09	<.001		345	251	36	1300
6/26/73	E3	<.008	<.004	.06	<.001		138	106	13	950
6/26/73	E2		.02		<.001		240	161	12	750
6/26/73	E1	<.008	<.004	.26			187	143	14	810
6/26/73	G3	<.008	<.004	.11	<.001		294	209	31	1300
6/26/73	G4	<.008	<.004	.10	~01		508	326	36	1950

CHEMICAL COMPOSITION OF WATER COLLECTED
AT THE TAILWATER SIDE OF S-7 PUMPING STATION
Analyses in PPM-ALK in Meq/l

Date	NO_3-N	NO_2-N	NH_3-N	DisOrg N	O-PO_4-P	DisOrgPO_4-P	Cl	Na	SiO_2	Alk
July 5	2.1	.048	.29	.23						
July 6	1.3	.075	.34	.14						
July 6	1.5	.076	.36							
July 9	.73	.035	.23							
July 9	.42	.024	.24	.30						
July 10	.71	.036	.25	.07						
July 10	.57	.030	.22	1.7						
July 11	.70	.042	.23	.26						
July 11	.75	.037	.22	.27						
July 12	.53	.032	.15	.21	<.002	<.01				
July 12	.53	.030	.09	.30	<.002	<.01				
July 13	.48	.037	.22	.14	<.002	<.01				
July 13	.29	.023	.17	.30	<.002	<.01				
July 16	.35	.038	.19	.17	<.002	<.01				
July 16	.22	.042	.21	.92	<.002	<.01	125	84	13	7.2
July 17		.056	.27	1.1	.004	<.01	162	99	15	8.0
July 17	.25	.044	.29	1.1	<.002	<.01	136	91	14	8.1
July 18	.25	.056	.37	1.2	.003	<.01	140	94	15	8.3
July 18	.27	.051	.34	1.1	.003	<.01	146	96	15	8.2
July 19	.27	.049	.33	.65	.011	<.01	152	99	15	8.0
July 19	.29	.049	.32	2.2	.002	.02	150	98	15	8.0
July 20	.27	.046	.30	1.0	.003	<.01	153	100	15	7.9
July 20	.23	.039	.25	1.1	<.002	<.01	147	97	15	8.1
July 23	1.2	.050	.26	1.7	.14		138	86	15	6.1
July 24	1.8	.076	.39	1.9	.40		138	88	14	5.9
July 24	2.4	.10	.43	2.4	.42		145	93	15	6.0
July 25	2.4	.11	.44	2.8	.35		143	90	15	6.4
July 25	1.2	.16	.26	2.4	.21	.13	147	93	17	6.5
July 26	1.8	.092	.48	2.5	.17	.01	151	95	17	7.2
July 26	1.7	.16	.42	1.9	.18		156	98	17	7.0
July 27	1.3	.12	.45		.08	.02	145	102	19	7.6
July 27	1.3	.11	.51		.13		148	103	18	7.3
July 28	.70	.083	.56	2.3	.086	<.01	145	102	20	7.5
July 28	.88	.11	.51	2.3	.11		155	119	19	7.2
July 29	1.4	.065	.49	2.0	.087		153	122	19	7.5
July 29	1.4	.097	.56	2.7	.088		168	126	20	7.3
July 30	1.0	.085	.54	2.4	.048		163	118	19	7.5
July 30	.66	.10	.41		.069	.01	136	104	19	7.9
July 31	.62	.099	.39		.090	.02	130	96	19	7.8

CHEMICAL COMPOSITION OF WATER IN CA-2A
AND ASSOCIATED CANALS - JULY 17, 1973

L38E and L35B Canals

Analyses in PPM-ALK in Meq/l

Sample #	NO_3-N	NO_2-N	NH_3-N	Dis Org N	O-PO_4-P	Dis Org PO_4-P	Cl	Na	SiO_2	Alk.
16	.46	.043	.20	.38	.006	<.01	146	115	16	8.2
17	.33	.014	<.01	.49	<.002	<.01	124	97	12	7.4
30	.34	.027	.05	.25	.005	<.01	138	107	14	7.9
31	.34	.022	<.01	.33	<.002	<.01	126	89	13	7.5
				MARSH						
7	.064	.009	.04	.56	<.002	.02	127	99	7.0	1.9
8	.034	.007	<.01	.43	<.002	<.01	91	74	9.7	2.2
9	<.016	<.004	<.01	.43	<.002	.01	91	76	13	2.8
10	.23	<.004	<.01	.18	<.002		322	242	11	3.6
11	.002	<.004	.07	.75		.04	302	225	15	3.9
12	.35	<.004	.06	.44	.005	.02	230	160	15	4.7
13	.003	<.004	.01	.41	<.002	.01	293	179	21	4.6
14	.073	.014	.06	.31	.003	.03	218	179	25	6.0
18	1.0	.055	.60	.06	.003	<.01	120	96	6.4	1.4
19	.045	<.004	.02	.45	.015	<.01	182	161	23	2.9
20	.35	.006	.16	.25	.005	<.01	121	100	6.9	2.1
21	.004	<.004	.01	.40	.004	<.01	170	130	13	3.0
22	<.004	<.004	<.01	.42	.013	<.01	151	120	27	2.8
23	<.004	<.004	<.01	.39	.002	.04	119	86	3.7	.77
24	.009	.009	<.01	.39	<.002	<.01	109	79	8.6	5.0
25	.044	.011			<.002	.02	89	66	6.4	1.0
26	.027	.012	.05	.35	<.002	<.01	103	78	9.2	2.9
27	.18	<.004	.03	.22	<.002	<.01	100	76	10	2.3
28	.079	.009	.05	.23	.002	.01	103		9.3	1.9
29	.020	.004	<.01	.26	.003	<.01	119	86	12	6.9
32	.083	<.004	<.01	.41	.003	<.01	51	43	14	2.2
33	.029	.010	<.01	.34	<.002	<.01	62	44	21	2.4

CHEMICAL COMPOSITION OF WATER COLLECTED
AT S-10 DISCHARGE GATES - JULY, 1973

Analyses in PPM-ALK in Meq/l

Sample #	Date	NO_3-N	NO_2-N	NH_3-N	Dis Org N	O-PO_4-P	Dis Org PO_4-P	Cl	Na	SiO_2	Alk.
G100701	7/24/73	.49	.028	.05	.66	.079	.03		205	17	2.3
G100702	7/24/73	1.6	.078			.002	<.01		175	21	6.5
GC20707-44	7/31/73	1.5	.15	.16	2.3	.026	<.01	161	128	15	4.7
GC20707-48	7/31/73	2.9	.23	.73	3.2	.17	.01	205	164	24	7.0
GC20707-49	7/31/73	2.4	.20	.42	3.2	.12	.02	189	160	20	6.5

CHEMICAL COMPOSITION OF WATER COLLECTED
IN CA-2A MARSH - JULY 31, 1973

Analyses in PPM-ALK in Meq/l

	NO_3-N	NO_2-N	NH_3-N	DisOrgN-N	O-PO_4-P	DisOrgPO_4-P	Cl	Na	SiO_2	Alk	Sp. Cond. (umhos/cm)
1	<.008	<.008	<.01	2.4	<.002	<.01	140	119	22	5.3	1050
2	<.008	<.008	.01	2.0	<.002	<.01	219	166	22	5.4	1300
3	<.008	<.008	<.01	2.4	<.002	<.01	65	48	16	2.6	540
4	<.008	<.008	<.01	2.0	<.002	<.01	28	21	7.1	1.0	220
5	.16	.048	<.01	2.7	<.002	<.01	208	172	19	5.2	1200
6	<.008	<.008	<.01	2.5	<.002	.01	32	24	10	1.0	240
7	<.008	<.008	<.01	2.5	<.002	<.01	96	67	16	3.1	700
8	<.008	<.008	<.01	1.8	<.002	<.01	150	121	15	4.8	900
9	<.008	<.008	.01	2.3	<.002	<.01	66	54	19	3.0	610
14	<.008	.013	.01		<.002	<.01	211	164	21	5.3	1200
19	<.008	<.008	<.01	2.6	<.002	.01	146	118	17	3.4	760
23	<.008	<.008	<.01	1.9	<.002	<.01	117	79	14	4.4	730
25	<.008	<.008	<.01	2.0	<.002	<.01	125	88	14	6.0	770
26	<.008	<.008	.03	2.4	<.002	<.01	91	78	12	3.6	400
27	<.008	<.008	.09	2.3	<.002	<.01	102	76	8.2	4.1	540
28	<.008	<.008	.03	2.0	<.002	<.01	81	60	6.1	2.1	390
29	.016	<.008	.03	1.9	.006	<.01	102	72	10	4.6	590
30	<.008	<.008	<.01	1.9	.002	<.01	93	65	6.6	3.7	610
32	.009	.023	.03	2.5	.003	<.01	182	146	14	6.0	1100
33	<.008	<.008	<.01	2.0	.005	<.01	116	80	8.3	3.2	540
34	.013	<.008	.02	2.0	<.002	<.01	103	76	5.4	3.4	440
35	<.008	<.008	<.01	1.7	<.002	.01	109	80	4.5	3.6	550
36	<.008	<.008	.02	1.8	.005	<.01	100	76	8.0	3.5	550
37	<.008	<.008	<.01	1.3	.003	<.01	131	97	7.1	3.2	830
38	<.008	<.008	<.01	2.0	<.002	<.01	133	90	13	7.7	840
41	<.008	<.008	<.01	3.1	<.002	.01	195	154	16	6.1	1100
42	<.008	<.008	<.01	1.2	<.002	<.01	55	45	9.5	3.4	480
43			.04	2.5	.006	.01	168	138	16	6.3	790
44	1.2	.18	.15	3.9	.086	.03	192	148	19	7.4	1300
45	.35	.28	.47	3.1			209	166	31	8.3	1500
46	<.008	<.008	<.01	2.4	<.002	.01	130	87	13	4.0	660

CHEMICAL COMPOSITION OF WATER COLLECTED IN HILLSBORO CANAL AND S-10 DISCHARGE CANAL - JULY 31, 1973

Analyses in PPM-ALK in Meq/l

	NO_3-N	NO_2-N	NH_3-N	DisOrgN-N	O-PO_4-P	DisOrgPO_4-P	Cl	Na	SiO_2	Alk	Sp. Cond. (μmhos/cm)
10	2.6	.28	.29		.067	<.01	150	120	16	4.8	1100
11	1.5	.15	.16	2.4	.026	<.01	161	128	15	4.7	1100
12	.056	<.008	.012	2.4	<.002	<.01	181	144	16	5.1	1100
13	2.8	.28	.36	3.3	.082	<.01	146	116	16	4.8	1100
15	2.9	.23	.73	3.2	.17	.01	205	164	24	7.0	1400
16	2.4	.20	.42	3.1	.12	.02	189	160	20	6.5	1200
17	2.7	.20	.96	3.0	.17	<.01	210	173	24	7.0	1500
18	2.9	.24	.61	3.3	.17	.02	199	166	24	6.7	1100
40	2.7	.30	.43	1.8	.094	.03	130	87	13	6.1	1100
					L38E and L35B Canals						
20	.67	.095	.23	2.7	.086		141	100	19	7.8	1100
21	.64	.058	.14	2.0	.080	.04	139	98	18	6.9	1200
22	1.3	.11	.24	2.0	.050	.02	146	118	18	7.5	1100
24	.80	.092	.36	2.5	.10	<.01	140	100	19	7.3	930
31	.086	.019	<.01	2.0	.004	<.01	128	86	16	7.6	1100
39	.82	.093	.38	1.9	.15		132	90	18	7.5	1100

CHEMICAL COMPOSITION OF WATER COLLECTED
AT S-10 DISCHARGE GATES - AUGUST 2-17, 1973

Analyses in PPM-ALK in Meq/1

	Sample No.	Structure	Date	NO_3-N	NO_2-N	NH_3-N	DisOrg N	O-PO_4-P	Dis Org PO_4-P	Cl	Na	SiO_2	Alk
	G10081	S10A	8/2/73	1.2	.15	.21	3.0	.026	.02	171	144	17	
	G10082	S10C	8/2/73	1.6	.18	.55	2.5	.10	.02	203	167	21	
	G10083	S10D	8/2/73	2.1	.18	.81		.096	.07	214	167	23	
S101	0-08093	S10A	8/9/73	.44	.076	.32	2.7	.043	.01	186	134	20	5.4
S102	"	S10C	8/9/73		.066	.45	2.6	.087	<.01	208	151	21	6.1
S103	"	S10D	8/9/73	.89	.10	.94	2.8	.15	<.01	195	167	23	7.7
S101	0-08133	S10A	8/13/73	.17	.047	.41	2.2	.043	<.01	159	121	19	4.7
S102	"	S10C	8/13/73	.13	.033	.24	2.4	.038	<.01	164	128	19	5.0
S103	"	S10D	8/13/73	.32	.077	.46	2.8	.071	<.01	218	164	24	6.1
S101	0-08173	S10A	8/17/73	<.008	<.008	.042	1.8	<.002	.012	114	75	15	3.1
S102	"	S10C	8/17/73	.14	.052	.48	2.4	.036	.03	207	150	20	5.8
S103	"	S10D	8/17/73	.68	.109			.063	.02	234	160	25	6.1

CHEMICAL COMPOSITION OF WATER COLLECTED IN
CA-2A AND ADJACENT CANALS - AUGUST 8, 1973

Hillsboro Canal at S-10 Structures and S-10 Discharge Canal

Analyses in PPM-ALK in Meq/l

	NO_3-N	NO_2-N	NH_3-N	DisOrgN-N	O-PO_4-P	DisOrgPO_4-P	Cl	Na	SiO_2	Alk
17	.75	.11	.67		.11	.02	212	178	24	6.6
23	.83	.12			.10	.03	221	174	24	6.8
25	.75	.11	.74		.15	<.01	218	173	32	6.8
26	.61	.10	.65		.13	.02	210	165	23	6.7
27	.30	.058	.28		.051	.01	180	142	19	5.4
28	.017	.008	.027		.005	.01	175	120	16	4.2
34	1.1	.20	.70		.084	.02	187	150	26	6.3
35	1.1	.21	.69		.088	.02	214	171	25	6.3

Conservation Area 2A Marsh

11	<.008	<.008	<.01		.002	.01	176	150	18	5.4
12	<.008	<.008	<.01		<.002	<.01	154	129	17	4.3
13	<.008	<.008	<.01		<.002	.03	160	135	18	5.4
14	<.008	<.008	<.01		.033	.02	175	145	20	5.6
15	<.008	<.008	<.01		<.002	.01	158	122	20	5.2
16	<.008	<.008	<.01		<.002	.01	175	143	19	5.5
18	<.008	<.008	<.01		.023	.02	188	148	19	5.4
19	<.008	<.008	<.01		<.002	<.01	210	128	15	4.6
20	<.008	<.008	<.01		<.002	<.01	203	162	27	5.1
21	<.008	<.008	<.01		.017	.02	150	160	27	6.4
22	<.008	<.008	<.01		<.002	<.01	205	111	19	3.7
24	<.008	<.008	<.01				199	155	33	5.3
29	<.008	<.008	<.01		.017	.03	213	159	20	6.0
30	<.008	<.008	<.01		.064	.02	191	166	20	6.2
31	<.008	<.008	<.01		<.002	<.01	201	144	21	6.0
32	<.008	<.008	<.01		<.002	.01	202	171	26	6.4
33	<.008	<.008	.01		<.002	<.01	212	180	26	5.8

CHEMICAL COMPOSITION OF WATER COLLECTED IN CA-2A
AND ASSOCIATED CANALS - AUGUST 14, 1973

Hillsboro Canal and Discharge Canal at S-10 Structures

Analyses in PPM-ALK in Meq/l

	NO_3-N	NO_2-N	NH_3-N	DisOrgN-N	O-PO_4-P	Dis OrgPO_4-P	Cl	Na	SiO_2	Alk
38	.33	.074	.85	2.3	.11	.001	209	145	22	6.7
39	.31	.071	.48	2.4	.003	.002	211	135	20	6.0
40	.31	.069	.46	2.5	.082	.004	212	135	21	6.0
41	.31	.067	.43	2.5	.080	.006			22	6.0
42	.084	.026	.30	2.1	.028	.005	157	113	19	4.2
43	.10	.031	.30	2.1	.028	.005	165	120	20	4.5
44	.26	.064	.80	2.4	.091	.003	202	151	20	6.7
46	.27	.065	.82	4.9	.003	.091	204	151	23	6.7

Conservation Area 2A Marsh

36	<.008	<.008	<.01	2.5	<.002	.001	203	141	21	5.6
37	<.008	<.008	<.01	2.0	<.002		166	116	18	4.5
45	<.008	<.008	<.01	2.5	<.002	.005	175	125	20	5.0
47	<.008	<.008	<.01	2.7	<.002		210	152	23	5.9
48	<.008	<.008	<.01	2.5	<.002	.001	155	122	19	5.0
49	<.008	<.008	<.01	2.3	<.002		158	124	18	4.4
50	<.008	<.008	.01	2.5	<.002		193	152	22	6.1
51	<.008	<.008	<.01	2.5	<.002	.002	193	147	22	5.9
52	<.008	<.008	.13	2.4	.066	.012	188	135	20	5.2
53	<.008	<.008	.29	2.4	.11	.012	208	165	24	6.2
54	<.008	<.008	.06	2.9	.081	.033	203	168	24	6.3
55	<.008	<.008	<.01	2.7	.019	.022	202	148	21	6.3
56	<.008	<.008	<.01	2.9	<.002	.004	186	162	23	6.5
57	<.008	<.008	<.01	2.9	<.002	.005	187	156	26	6.4
58	<.008	<.008	<.01	3.1	.025	.016	201	166	29	6.6
59	<.008	<.008	<.01	3.1	.019	.019	197	166	27	7.0
60	<.008	<.008	<.01	2.4	.028	.030	76	112	18	4.4

CHEMICAL COMPOSITION OF WATER IN
CA-2A MARSH - AUGUST 22, 1973

Analyses in PPM-ALK in Meq/l

Sample #	NO_3-N	NO_2-N	NH_3-N	Dis Org N	O-PO_4-P	Dis Org PO_4-P	Cl	Na	SiO_2	Alk.	Sp. Cond.
80	<.008	<.008	.04	2.1	.025	.019	147	108	18	4.3	920
86	<.008	<.008	.23	2.4	.087	.033	185	131	20	4.9	1200
88	<.008	<.008	.02	2.7	.039	.032	207	145	24	6.2	1380
89	<.008	<.008	.02	2.6	.046	.036	207	155	26	5.9	1390
90	<.008	.013	<.01	2.5	.020	.032	213	164	24	5.9	1400
91	<.008	<.008	<.01	2.5	.028	.029	219	163	25	6.2	1420
92	<.008	<.008	.01	2.6	.037	.033	215	164	26	6.1	1420
93	<.008	<.008	.01	2.4	.035	.033	214	162	25	6.0	1430
94	<.008	<.008	.01	2.3	.005	.021	183	127	22	4.9	1210
95	<.008	<.008	.01	2.4	<.002	.020	150	101	19	4.3	1010
96	<.008	<.008	.01	2.4	<.002	.018	194	134	20	5.2	1280
97	<.008	<.008	.02	2.0	<.002	.012	151	101	18	4.3	1030
98	<.008	<.008	.01	2.2	<.002	.010	160	107	20	4.6	1060
99	<.008	<.008	.02	1.9	<.002	.004	140	90	17	3.8	910
100	<.008	<.008	.04	2.4	<.002	.009	185	133	26	5.3	1200
101	<.008	<.008	.02	2.4	<.002	.010	183	131	27	5.4	1240
102	<.008	<.008	.01	2.6	<.002	.009	199	143	28	5.7	1300
103	<.008	<.008	.03	2.1	<.002	.008	160	105	18	4.5	1080
104	<.008	<.008	.01	2.5	<.002	.007	190	130	22	5.4	1280
105	<.008	<.008	.01	2.6	<.002	.006	192	133	22	5.5	1250
106	<.008	<.008	.02	2.7	<.002	.009	204	140	27	6.1	1350
107	<.008	<.008	.04	2.4	<.002	.012	184	124	22	5.2	1210
108	<.008	<.008	.06	2.4	<.002	.008	188	128	25	5.3	1250
109	<.008	<.008	.01	2.2	<.002	.005	173	116	18	4.8	1100
110	<.008	<.008	.05	2.7	<.002	.009	245	147	29	6.1	1350
116	<.008	<.008	<.01	1.5	<.002	.002	61	40	16		410
117	<.008	<.008	<.01	2.0	<.002	.002	120	82	21		780
118	<.008	<.008	<.01	1.6	.008	.015	143	96	20		1230
119	<.008	<.008	<.01	1.7	<.002	.011	133	88	19		1100